COMPETITION IN THE ACQUISITION OF MAJOR WEAPON SYSTEMS

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THESIS

COMPETITION IN THE ACQUISITION OF
MAJOR WEAPON SYSTEMS

by

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September 1979

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) COMPETITION IN THE ACQUISITION OF MAJOR WEAPON SYSTEMS		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis SEPTEMBER 1979
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Benjamin Russell Sellers		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE September 1979
		13. NUMBER OF PAGES 127
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Second Sourcing Acquisition Strategy
Competition Major Weapon Systems Acquisition
Secondary Sourcing Method Selection Model

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The objectives of this research are: (1) to examine the desirability of competition as expressed by current leaders in the field of major systems acquisition in DOD, in Congress, and in private industry; (2) to evaluate the adequacy of the guidance provided by the current acquisition instructions concerning the need, and the methods available, for generating competition in the acquisition of major weapon systems; and (3) to provide recommendations for improving the guidance.

contained in the instructions, including the development of a model to aid in making decisions regarding production competition.

The results of this research indicate that competition is highly desirable, but that the subject is not adequately addressed in the current instructions. The major contribution of the study is the development of a production competition decision-making model which is presented in Chapter V. This chapter presents the benefits and various methods of obtaining a second production source. Also included is a discussion of the factors which influence the second sourcing decision and a model for determining which of the second sourcing methods, if any, is best suited for any particular acquisition program. It is written as a stand-alone chapter for use as a desk-guide by program managers and/or contracting officers who are faced with making decisions regarding production competition.

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Submitted in partial fulfillment of
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
September 1979

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I. INTRODUCTION

A. OBJECTIVES OF THE RESEARCH

The objectives of this study were: (1) to determine the desirability of generating competition in the major weapon systems acquisition process, (2) to evaluate the adequacy of the guidance regarding competition provided by the current acquisition instructions, (3) to investigate the methods available for generating a second source, and (4) to develop a model to aid in determining the viability of generating a second source and/or production competition for any particular acquisition program.

B. RESEARCH QUESTIONS

In pursuing the objectives of the research, the following questions were addresses:

1. Do the instructions provide an adequate definition of competition in the context of major weapon systems acquisition?

2. Is competition desirable in the acquisition of major weapon systems?

   a. What is the current Federal/Department of Defense (DOD) policy regarding competition?

   b. Do members of Congress consider competition to be desirable?

   c. Do industry representatives consider competition to be desirable?

3. Is the concept of competition adequately addressed in current acquisition policy statements and instructions?

4. Is it feasible to develop a model which will aid the program manager to determine whether or not production competition will be beneficial to his program and which second sourcing method is best suited for his acquisition program?

C. RESEARCH METHODOLOGY

The information presented in this study was obtained primarily from the currently available literature on the subject of major weapon systems acquisition. The literature base utilized in this study includes current acquisition directives and instructions (specifically DOD Instructions 5000.1 and 5000.2 of January 1977 and OMB Circular A-109 of April 1976), texts of Congressional hearings, acquisition studies prepared by the military departments, previous theses and dissertations, and studies prepared by private companies such as the Rand Corporation, the Logisitcs Management Institute, and the Institute for Defense Analysis.

D. SCOPE OF THE STUDY

The scope of this study is essentially limited to weapon system acquisitions and to buys of major components of such systems. However, the researcher knows of no reason why the recommendations presented herein could not be applied to the acquisition of components or systems other than major weapon systems.

E. ASSUMPTIONS

Throughout this thesis it is assumed that the program manager is free to develop competitive sources where it appears to be advantageous and that there is one or more

qualified contractors who are eager to become a second source for the system being procured. It is also assumed that the reader is familiar with standard DOD contracting terminology and concepts and with DOD program management structure, operation, and terminology.

F. ORGANIZATION OF THE STUDY

This thesis is organized in the same sequence as the research questions. Chapter II describes the major weapon system acquisition process, discusses the importance of the Acquisition Strategy, and defines the concepts of competition and second sourcing. Chapter III assesses the desirability of generating competition in the acquisition process. This chapter includes statements made in the acquisition instructions, as well as statements made by Congressmen and industry representatives. Also included in Chapter III are discussions of the benefits and problems associated with competition and the alternatives available to the program manager in the absence of competition. Chapter IV analyzes the adequacy of the guidance relative to competition provided by the current acquisition instructions. Chapter V presents an evaluative model which can be used by a program manager as an aid in determining whether or not to pursue production competition as part of his acquisition strategy. This model was developed in cooperation with LCDR D.S. Parry, SC, USN and was included in his thesis entitled, "Second Sourcing in the Acquisition of Major Weapon Systems." Finally, Chapter VI presents the conclusions drawn from this research and provides recommendations

for improving the guidance contained in the acquisition instructions. In addition, the Appendices (particularly C and E) provide valuable related information for the interested reader.

II. FRAMEWORK AND DEFINITIONS

A. THE MAJOR WEAPON SYSTEM ACQUISITION PROCESS

Appendix A presents the major events and decision points (milestones) of the acquisition process in graphic form. The acquisition process begins with the recognition by the Secretary of Defense (SECDEF), or by one of the DOD component heads, that a mission element is deficient in its existing or projected capability to meet its essential mission needs. Formal documentation of the deficiency is forwarded to the Secretary of Defense in the form of a Mission Element Need Statement (MENS). The MENS is limited to ten pages and is used to "recommend the initiation of new systems acquisition programs and to document the mission need and the essential supporting and planning information. [4:5]

> "When a mission need is determined to be essential and reconciled with other DOD capabilities, resources, and priorities, the Secretary of Defense will approve the mission need and direct one or more of the DOD components to systematically and progressively explore and develop alternative system concepts to satisfy the approved need." [3:3]

This decision by SECDEF is represented by Milestone 0 in the flow chart. Current policy provides the following guidance for Phase I of the acquisition process: when feasible the need shall be satisfied with existing military or commercial items; when a modification or new development is required, the needs of other DOD components and NATO standardization and interoperability shall be considered; competition shall

be emphasized among alternative systems so that the best possible solution may be selected. Phase I includes the solicitation of ideas from industry as well as from academic and government sources. The solicitation must be stated in terms of the mission need, not in terms of the capabilities or characteristics of a hardware or software system. The responses to the solicitation are evaluated and a Decision Coordinating Paper (DCP) is prepared by the program manager. The DCP is forwarded to SECDEF via the Service System Acquisition Review Council ((S)SARC) and the Defense System Acquisition Review Council (DSARC), recommending the systems which should proceed into Phase II, demonstration and validation. SECDEF reaffirms the mission need and approves one or more alternatives for competitive demonstration and validation. This action is represented by Milestone I in Figure 1 of Appendix A.

In Phase II competitive demonstrations are conducted to validate the design concepts and to provide a basis for selection of the preferred systems for full-scale engineering development. The demonstrations should be conducted with full-scale prototypes in realistic operating environments where feasible and practical. Recommendation for a system to proceed into full-scale engineering development should be made based on the system's demonstrated ability to meet the mission need, an evaluation of the remaining risks and potential resolutions, an evaluation of the estimated acquisition and ownership costs, and such factors as the

contractor's demonstrated management, financial, and technical capabilities to meet program objectives. /16:19/ This recommendation is forwarded in the form of an updated DCP to SECDEF via the (S)SARC and the DSARC. SECDEF again reaffirms the mission need and approves the selection of the systems for full-scale engineering development at Milestone II on the flow chart.

During Phase III, full-scale engineering development is undertaken by the contractors and initial production units are fabricated. These units are tested and evaluated by an organization independent of the development and user organizations. The purpose of this independent testing is to insure effective performance under expected operational conditions. Also during this phase, the contractors develop and submit proposals for production. These proposals and the test results are evaluated and one (or conceivably more than one) of the systems is recommended for production and deployment. An updated DCP is prepared for SECDEF's Milestone III decision. Phase IV, production and deployment of the system, completes the acquisition process.

B. ACQUISITION STRATEGY

One of the program manager's first responsibilities is to develop an Acquisition Strategy tailored to the requirements and constraints of his particular program. The Acquisition Strategy is a document which becomes the underlying framework for the entire acquisition process. Its purpose is to integrate the myriad of technical, schedule,

business, and management considerations into a coordinated plan for the achievement of program objectives in an effective and efficient manner. The pervasive nature of the Acquisition Strategy is presented in an excerpt from OFPP Pamphlet No. 1 which is presented in Appendix B. In the view of this researcher, the nature and extent of competition to be generated in the acquisition program is one of the cornerstones on which the Acquisition Strategy rests.

C. DEFINITION OF COMPETITION

Before proceeding with a discussion and evaluation of the desirability of competition, it is necessary to clearly establish and define the concept of competition. The Defense Acquisition Regulation (DAR) (formerly the Armed Services Procurement Regulation) provides the following information relative to competition:

> Price competition exists if offers are solicited and (i) at least two responsible offerors (ii) who can satisfy the purchaser's (e.g., the Government's) requirements (iii) independently contend for a contract to be awarded to the responsive and responsible offeror submitting the lowest evaluated price (iv) by submitting priced offers responsive to the expressed requirements of the solicitation. [2:3:120]

The program manager, however, needs a more complete "working" definition in order to effectively incorporate competition into his Acquisition Strategy. For example, the program manager must be cognizant of the existence and importance of the two basic types of competition, namely <u>design competition</u> and <u>production competition</u>. In addition, he must be able to distinguish between the economist's

concept of "perfect" competition and the concept of effective competition relative to both the design and production phases of his program. Without an understanding of these distinctions, the program manager can not hope to develop an optimal competitive strategy.

1. Design vs. Production Competition

One of the major conclusions of this research is that design competition and production competition must be recognized as independent concepts. In the past, in DOD instructions, in Congressional testimony, and probably in the minds of program managers themselves, competition has been thought of in the generic sense. That is, an acquisition program was thought of as being competitive so long as it included either type of competition. There appears to be some consensus that if the source selection is delayed long enough so that the configuration of the system has been substantially established under "competitive pressures", then the benefits of the design competition will "carry-over" into the production of the system. /19:49/ The "carry-over" theory was supported by Senator Hart in 1969 when he said:

> If two contractors were undertaking the design of a system, working in a competitive environment, building prototypes, knowing that only one would be awarded the ultimate contract for the manufacture of the system, I believe this would provide the strongest possible inducement to design a system that is economical to manufacture and to operate. I believe this competition would be good for the taxpayers. /19:49/

The following exchange, in 1974, between Senator Symington and Dr. John S. Foster, Jr. (then Director of Defense Research and Engineering), relative to the prototype

competition between Sikorsky and Boeing Vertol for the Army's UTTAS helicopter, also directly supports the carry over theory in that it assumes that a lower production price will be the direct result of competitive development:

> Dr. Foster: You, Mr. Chairman, know nothing that we have found is so effective, when it comes to making equipment work satisfactorily and better than we had estimated, than to have two competitors working head to head with hardware in the field and making the necessary changes in order to improve the situation.
>
> Senator Symington: Does the hope of long term savings due to price competition justify the expenditure of some $150 million additional to carry two contractors through development?
>
> Dr. Foster: Yes, sir. /19:50/

It is unfortunate that the independent concepts of design competition and production competition have been allowed to overlap in the language of acquisition. This overlap leads to confusion about the nature of the two types of competition and their relationship to each other. Specifically, the imprecise terminology has led to erroneous concepts like the carry-over theory. The following discussion, however, will show that the two types of competition are independent, that they serve different purposes, and that achieving the dual goals of obtaining the best system at the lowest fair and reasonable price generally requires the generation of both design and production competition.

Design competition is the process of generating alternative potential solutions to satisfy a mission need, and the selection of the best system, price, and other factors

considered. During the competitive design phase, prior to source selection, the contractors are required to estimate the future life cycle costs of their respective systems. It is emphasized that these estimates -- although they must be supportable and they are carefully reviewed by the government -- are neither firm nor ceiling prices for future production. They are simply "best guess" estimates. The goal of design competition, as expressed by Deputy Secretary of Defense Charles W. Duncan, Jr., "is to award the contract to the best technical proposal within a realistic affordable price." (Emphasis added). He further states that in the process of selecting the winning design, "the price negotiation is constrained to verification of its realism." [5:10] It is interesting to note that there is no mention of the "lowest fair and reasonable price" as a goal of the design competition.

Production competition, on the other hand, is the process of obtaining competitive offers from two or more independent, qualified manufacturers for the production of identical, or functionally identical, hardware or software systems. The goal of production competition is to obtain the lowest fair and reasonable price for the procurement and the operation and maintenance of the system which was selected in the competitive design phase. Regardless of "promises" or projections made about production and life cycle costs in the design phase, once a system is selected and a sole source situation occurs, there is little actual incentive for the

contractor to work to minimize production costs. Consider for example, the results obtained under Total Package Procurement. This approach would seem to be the ultimate vehicle for maximizing the benefit of the carry-over effect, because the cost of all the production units were negotiated under the intense pressure of competitive source selection. However, Total Package Procurement is now specifically forbidden by DOD Instruction 5000.2 because of its notable failures in the C-5A, DD-963, and F-14 contracts. It seems that under intense competitive pressure, a contractor will promise almost anything -- will even "buy-in" on a binding fixed price-incentive basis -- with the intention of making up the difference in changes and/or claims during production.

Given the experience with the Total Package Procurement, it should be clear that if maximum benefit is to be obtained from competition, the program manager must give careful consideration to generating both design and production competition. It is not sufficient for a program to be considered competitive just because it includes one of the two types.

One further point should be made with respect to the invalidity of the "carry-over" theory -- The following is from a study performed at the Defense Systems Management School in 1974:

> During a visit to the Defense Systems Management School in September 1974, General Henry Miley, Commander, U.S. Army Materiel Command, expressed concern that competitive prototype development under cost-plus incentive fee contracts might also include increased potential for cost growth and

goldplating. The thesis is that the prime motivator for the contractors is to win the follow-on contract. This dominant motivator then renders the cost incentive fee ineffective in that the contractor will spend whatever he feels is necessary to win. The competitive aspect of this situation might also lead the contractors to add a little goldplating to their product if they perceive it will give them an edge over their competition at source selection for the follow-on contract.

Research of existing literature revealed no discussion of these potential disadvantages of competitive prototype development. Interviews with procurement experts and project managers were conducted to determine if they felt there was basis for this concern.

The interviews confirmed that a cost incentive fee was ineffective in competitive prototype validation and that the competitive aspect of this situation could increase the potential for cost growth and goldplating.

The conclusions are that General Miley has identified an additional potentially very costly, disadvantage to competitive prototype development. This is not to say that this type of development is not useful. On the contrary, being aware of the pitfalls will enable the government to practice the concept of competitive prototype development to its greater advantage. /6:ii/

While the study reported above does not argue against the use of prototype competition, it does provide additional evidence that design competition does not automatically lead to a lower-priced system. The results of this study add emphasis to the proposition that the acquisition community in general, and the program manager in particular, must recognize the independence of the two types of competition and the need for both design and production competition in a well-structured Acquisition Strategy.

2. Perfect Competition vs. Effective Competition

The economist's definition of perfect competition is based on the existence of four essential market conditions. First, there must be a homogeneous product such that the

product offered by any one seller is identical to that offered by all other sellers. Second, there must be many buyers and many sellers such that no one buyer or seller can unilaterally affect the price of the product. Third, there must be no barriers to entry or exit from the market. Fourth, both buyers and sellers must have perfect knowledge of all relevant economic and technological data affecting the market for the product. /8:234/

Obviously, since the defense market consists essentially of a single buyer, since there are significant barriers to entry and exit, and since none of the players has "perfect knowledge" of the economic and technological data, the program manager is not seeking (and does not desire) a perfectly competitive environment in which to procure defense systems. In most situations, however, the program manager will find it beneficial if he is able to create "effective" competition. Effective competition exists when the expected value of the benefits to be derived from competition exceed the expected costs of creating competition. It should be noted that both the benefits and the costs of competition can be measured in monetary and/or non-monetary terms. For example, the value of expanding the production base for a critical weapon system is a benefit which cannot be measured in monetary terms. Similarly, the loss of a critical contractor due to the rigors of competition could be a non-monetary cost.

The concept of effective competition is directly tied to the creation of a monopsonistic market. That is,

a market consisting of a single buyer and several sellers. The existence of a monopsonistic market enhances the program manager's likelihood of obtaining the high quality equipment he needs, when he needs it, at a fair and reasonable price.

One of the critical questions in the creation of this market is: "How many 'sellers' are needed in order to generate effective competition?" The answer to this question depends on a variety of factors. As is shown in Figure 2 of Appendix A, the number of sellers decreases as the acquisition cycle progresses. Therefore, the number of sellers which are needed is influenced by the phase of the acquisition process for which competition is being considered. Other important factors are the quantity of the item being procured and the start-up costs associated with production of the item. Effective competition in the design phase usually includes many different potential sellers. In the production phase, however, cost-effectiveness considerations may reduce the number of sellers to only one or two. If only one seller is selected for production, then the monopsonistic market (and the opportunity for competition) will disappear. The program manager will then find that he has become one half of a bilateral monopoly. This situation -- one buyer and one seller -- is typical of the production phase of most current major weapon system acquisition programs.

D. SECOND SOURCING

The term "second sourcing" will be used repeatedly in the following chapters. Second sourcing can be defined as the establishment of two or more qualified and independent sources for the production of hardware or software to satisfy a particular need. There are several potential benefits associated with second sourcing and there are at least five different methods which can be used to establish a second source. The various benefits and methods are discussed in detail in Chapter V. It is important at this point to recognize that second sourcing and production competition are interdependent concepts. That is, in order to generate effective production competition, the program manager must insure that there are two or more sources who can produce the system under consideration. Also, when second sourcing is undertaken, for whatever reason, it is reasonable to assume that the program manager will benefit from generating a competitive environment for the acquisition of the system.

III. DESIRABILITY OF COMPETITION

This chapter examines the desirability of competition in terms of current acquisition policy documents and public statements made by DOD officials, members of Congress, and representatives of private industry. Also presented in this chapter are the potential benefits of competition, the potential problems associated with generating production competition, and a discussion of the alternatives available to the program manager in the absence of competition.

A. POLICY STATEMENTS

Even a casual review of the regulations, instructions, or literature relative to acquisition management reveals the universal popularity of competition. As evidence of this, consider the following:

* Deputy Secretary of Defense Duncan made the following statement in May of 1978:

> Before instituting any acquisition procedure, we must first recognize that we are dealing in a free enterprise society. When we go to industry to get proposals for building our defense systems, we must recognize that competition essentially dictates success or failure of the companies with which we deal. Those companies which are successful are so because they have learned how to compete effectively. It is fundamental to any of our acquisition procedures that we find ways to take maximum advantage of this competition. /7:2/

* The Defense Acquisition Regulations (formerly the Armed Services Procurement Regulations) very clearly state the preference for competition in the form of formally advertised procurements.

* DOD Instruction 5000.1 requires that the program manager "direct the program to include maximum use of effective competition throughout the system acquisition process." /3:6/

* DOD Instruction 5000.2 directs that competition "shall be a major factor in the acquisition strategy throughout the program to achieve technical innovation, reduced risks and cost and effective management. /4:9/

* OMB Circular A-109 states that the acquisition strategy should "encompass methods for obtaining and sustaining competition." /17:5/ Furthermore, A-109 requires that "disclosure of the basis for an agency decision to proceed with a single system design concept without competitive selection and demonstration will be made to the Congressional authorization and appropriations committee."/17:11/

* Members of Congress favor competition as is revealed in the following dialogue between Senators Proxmire and Chiles:

> Senator Proxmire: We need competition early, we need it late. We need it at all points in a procurement process, more competition than we have now....If you do not get that competition in early, you are missing, I think, the principal value of competition.
>
> Senator Chiles: I agree that we should be getting more competition. /13:12/

* Representatives from industry recognize the value of competition in the acquisition process. For example, Mr. George Schairer, Vice President of The Boeing Company, stated in Congressional hearings, "To me, the best way to keep the costs in hand and the quality of the weapons up, is through the mechanism of competition." /13:99/ Furthermore, the 15

member Commission on Government Procurement, which included many influential businessmen, emphasized the importance of competition in several of their recommendations to the President.

B. BENEFITS OF COMPETITION

Very simply, competitive pressures are widely believed to lead directly to the development of better systems at lower prices. As was discussed in the previous chapter, the realization of these dual benefits requires the creation of both design competition and production competition.

Design competition is generated by defining a need in terms of the mission which must be performed and by encouraging industry-wide participation in the generation of potential solutions. It is felt that a greater number of alternatives will be found by using a competitive approach than if a single contractor were chosen to design a system to satisfy the Government's need. Careful examination of the alternatives is expected to lead to the selection of two or more which are suitable for further development and evaluation. Ultimately, the design which offers the best combination of performance and expected life-cycle cost will be selected. A technique for creating design competition called "parallel undocumented development" has the potential not only to generate the best technical solution, but also to reduce the development cost of the competing prototypes. In a study performed by Barry R. Lenk for the Office of Naval Research, this method of development was described as follows:

One of the most promising forms of prototyping is called "parallel undocumented development", in which competing companies develop prototypes with the minimum amount of documentation needed by the contractor. The Government evaluates and tests the competing prototypes in order to select a winner who undertakes the documentation necessary to manufacture the system. As a result, the design for configuration management purposes is frozen at a much later date in the development cycle, and the contractor gains substantially more responsibility and flexibility during the development phase. In addition, the decrease in required documentation should result in decreased cost of development, as high as 50% according to some estimates. /10:18/

With respect to the cost savings potential of competitive versus sole source procurement, the following are examples of the estimates which have been derived by various organizations:

* One of the most frequently quoted estimates was provided by Secretary of Defense McNamara in 1965, when he stated to the Joint Economics Committee of Congress that savings on the order of 25% or more generally resulted from a conversion to competitive procurement from sole source. /7:1/

* Later in the same hearings, Mr. William Newman of the General Accounting Office indicated that the estimate of 25% savings was conservative, based on GAO audit findings. /11:26/

* A 1964 study by the Logisitcs Management Institute developed average savings of 22.5% experienced in competitive subcontracting by a major prime contractor. /11:27/

* A 1972 study performed by the Army Electronics Command reported average savings of 54% from the competitive procurement of several electronics equipments. This study also stated, "reasonable confidence could be attached to using at least a 40% reduction for planning purposes." /20:1/

* A 1978 study by the Army Procurement Research Office reported average savings of 10.8% on sixteen items which were shifted from sole source to competitive procurement. It is worth noting that five of the sixteen items included in the study showed a net loss rather than a savings, and that the 10.8% figure is the net savings after deducting the cost of generating competition. For the eleven items which did show a net savings, the savings ranged from 2.7% to 51%, with an average of 18% -- after deducting the estimated cost of generating competition. [12]

* A particularly interesting example is provided in a report by David V. Lamm which indicates that a price reduction of more than 50% was realized when a sole source producer of missile rocket motors discovered that the Naval Air Systems Command was merely initiating actions to develop a second source. [9:4]

When viewed with respect to the overall DOD procurement budget, these potential savings are truly dramatic. With a 1980 procurement budget of approximately 35 billion dollars, every 10% increase that can be generated in production competition represents potential savings of between 500 million and 1 billion dollars per year (assuming the average savings resulting from competition is between 15 and 30 percent.)

Another potential benefit of competition, especially prototype competition, is that it may speed up the development process. In Congressional testimony, Mr. George Schairer of The Boeing Company said:

> Our AWACS prototype has been terribly important. It allowed us to learn things and make progress that would never have been possible any other way. It speeded the process up. The prototype, in fact, led us to a better weapon sooner. /13/

An indirect benefit of competition is that it lends an air of credibility and fairness to the source selection process. It has been suggested that much of the attraction, from the viewpoint of Congress, lies in the appearance of evenhandedness and equity inherent in competitive procurement. /19:55/

C. POTENTIAL PROBLEMS

There are several problems, or potential problems, associated with the generation of production competition, such as:

* Additional front-end costs -- There are additional tooling and start-up costs as well as technical data package and/or technology transfer costs associated with establishing a second source. In order for production competition to be cost-effective, the additional cost must be more than compensated for by reduced procurement and ownership costs.
* Willingness of contractors to participate -- Difficulties may be experienced in securing the cooperation of the original developer or in obtaining offers from qualified second sources. This is particularly true when the system to be procured also has extensive commercial as well as military applications.
* Maintenance of the data package and coordination of engineering changes is more complicated when more than one contractor is involved in production of the system.

* Dilution of learning curve/economies of scale -- Dividing the production quantities between two or more sources reduces the beneficial effects of the learning curve and eliminates some economies of scale.

These, and other problems have been raised, suggesting that effective production competition may not be feasible or desirable. For example, in 1969 GAO cited these problems in concluding that "the Directed Licensing technique would not provide a workable soluting to the problem or reducing the cost of major weapon systems." /21/ However, a 1974 Rand Corporation study by Greg Carter countered each of the potential problems cited in the GAO report. /1/

It is the opinion of this researcher that the program manager must be sensitive to these potential problems. However, in the vast majority of cases, the problems can be either eliminated or minimized by proper advance planning, early and forthright communication with the contractors, and selection of an appropriate second sourcing method.

D. ALTERNATIVES TO COMPETITION

In order to protect its interest, in the absence of competition the Government usually resorts to considerable (some would say excessive) involvement in the development and production process. For example, the absence of design competition implies that either the Government specifies the design of the hardware or it contracts with a single firm as the design agent. In either case, creativity and innovation are curtailed, with the result that some very

attractive alternatives may be completely overlooked. In addition, the Government is inclined to "over-manage" the development effort by insisting on extensive documentation and reporting requirements during the development phase.

The absence of production competition has similar drawbacks. When contracting with a sole source, the Government attempts to protect its interests and create effective cost control through a variety of techniques such as: (1) the use of incentive contracts, (2) the requirement for extremely detailed cost and pricing data under the authority of Public Law 87-653 (the Truth in Negotiations Act), (3) aggressive negotiations which sometime take months to reach agreement on a single contract, (4) involvement in the contractor's make-or-buy decisions, (5) component breakout decisions, (6) the conduct of should-cost studies, (7) the use of value-engineering change clauses, and (8) in the past, the services of the Renegotiation Board. Most of these techniques could be eliminated, as well as the thousands of pages of reports they require, if the acquisition were conducted on a competitive basis.

The use of incentive contracts as a means of controlling costs and motivating contractors to be efficient producers is so prevalent in today's world of sole source contracting that it deserves special discussion. Appendix C provides such a discussion and concludes that incentive contracts are relatively ineffective at inducing contractor efficiency and cost control.

The "bottom line" of this section on Alternatives to Competition, is that effective competition in both design and production is more valuable in terms of obtaining the best system at fair and reasonable prices than all the alternatives to competition which the Government so frequently uses.

IV. ANALYSIS OF CURRENT INSTRUCTIONS

The previous chapter provided evidence of the universal popularity of the use of competition in major weapon systems acquisition. The gudiance contained in the major instructions dealing with systems acquisition make it very clear that the official policy of the Department of Defense is to employ the maximum use of competition in order to obtain the required weapons at the lowest fair and reasonable price. The instructions, at least in general terms, emphasize the need for competition throughout the acquisition process.

A closer review, however, reveals that despite the wholehearted support for competition found in the current instructions, the actual guidance provided on the subject appears to be deficient. The deficiency can be stated as (1) a failure in the instructions to distinguish between the concepts of design dompetition and production competition, and (2) a lack of guidance for program managers with respect to the need for and the methods of generating production competition.

The current instructions, specifically DOD Instructions 5000.1, 5000.2, and OMB Circular A-109, state in considerable detail, the reasons for and the nature of the required design competition. For example, the instructions state that the primary method for generating design competition is based on the widest feasible solicitation of industry, educational institutions, and Government laboratories for concept formulation proposals. Whenever possible, prototypes will

be used as the basis for testing the capabilities of the most promising designs. The following additional guidance is also provided:

* DOD Instruction 5000.1 requires that:

> Competent industry and educational institutions, regardless of size shall be the primary sources for the exploration of competitive system design concepts. Government laboratories, federally funded research and development centers and other not-for-profit organizations may also be considered as sources. /3:5/

* DOD Instruction 5000.2 says the following with respect to prototype demonstrations:

> Competitive demonstrations should be conducted with full scale prototypes in realistic operating environments when feasible and practical. When demonstrations at the system level are not feasible or are impractical, competitive prototype demonstration of critical subsystems shall be considered in the same manner as systems. /4:9/

* OMB Circular A-109, in addition to the requirement cited earlier to report the rationale leading to a non-competitive design selection to Congress, also gives the following guidance:

> Development of a single system design concept that has not been competitively selected shall be considered only if justified by factors such as urgency of need, or by the physical and financial impracticability of demonstrating alternatives. /17:10/

While the instructions do not absolutely require the use of design competition, they make it clear that non-competitive design selection is expected to be the rare exception, rather than a convenient alternative. These statements also indicate that program managers are expected to include in their acquisition strategies full-scale prototype competition, or at a minimum, competitive prototype demonstration of critical subsystems.

The instructions do not discourage production competition, however, they are completely silent on the subject except for an occasional reference to general principles, such as the need for "effective competition through the program," or the desirability of "obtaining and sustaining competition." The significant deficiency is that in the one hundred or more instructions applicable to the management of major systems acquisition, there is no mention of the types of possible production competition or the methods by which production competition can or should be generated.

A review of Senate Bill S-5, which is currently under discussion in Congress, reveals similar deficiencies. Entitled the "Federal Acquisition Reform Act," this bill proclaims the importance of competition as a means of cost reduction, as a substitute for regulatory controls, and as an incentive for innovation and application of new technology in the private sector to meet the needs of the federal government. When viewed from the standpoint of its effect on the amount of competition generated in major systems acquisition, the bill seems to be primarily a formal recognition by Congress of the principles of OMB Circular A-109. For example, the bill incorporates the philosophy of A-109 in the following areas:

* Requirements should be stated in terms of functional need, not in terms of hardware design, so that, "prospective suppliers will have maximum latitude to exercise independent business and technical judgments in offering a range of competing alternatives."

* Large scale acquisitions are to be initiated "only after the item or equipment to be acquired has been proven adequate by operational testing."

* For competitive procurements where price is a "primary or significant factor, the Government's evaluation shall be based, to the maximum extent practicable, on the total cost (i.e., life cycle cost) to meet the public need.

* When awards are made for alternative approaches,.... whether for design, development, demonstration, or delivery, the contractors shall be sustained in competition <u>until sufficient test or evaluation information becomes available to narrow the choice to a particular product or service</u>. (Emphasis added) Once again, design competition is mandated when practical, but production competition is ignored.

With respect to production competition, S-5 states that in the event that a non-competitive source selection is made:

> Where there is no commercial usage of the product or service ... and the military department head determines that substantial follow-on provision of such product or service will be required by the Government, the military department head shall, <u>when he deems appropriate</u>, take action through contractual provision or otherwise, to provide the Government with the capability to establish one or more other competitive sources. (Emphasis added)

This paragraph in S-5 at least mentions the idea of production competition. However, it seems to be directed to situations where the original source selection was made in a non-competitive environment. Furthermore, the wording of the paragraph itself is weak, in that it gives the military department head the <u>authority</u> (which he already has) to seek a second source for production, rather than requiring him to do so.

If it is signed into law, the Federal Acquisition Reform Act may have a significant impact on the federal acquisition community in general; however, it will probably have little, if any, impact within DOD with respect to increasing the amount of competition, particularly production competition, generated in the acquisition of major systems.

In summary, it is the opinion of this researcher that the current instructions adequately address the concept of design competition, but that they are deficient with respect to the subject of production competition.

The next chapter presents information relative to second sourcing and production competition which should be made available to program managers in order to strengthen the guidance provided to them on the subject of competition.

V. THE SECOND SOURCING METHOD SELECTION MODEL (SSMSM)

A. PREFACE

As outlined in Harvey T. Gordon's memorandum of 13 February 1979 /Appendix D/, there are a number of techniques for establishing a second source for production of a weapon system. The process of deciding which, if any, of these techniques to use should follow a logical series of steps: (1) specific objectives/policy goals to be fulfilled must be clearly stated and understood, (2) a determination must be made as to the adaptability of the project in question to second sourcing, and (3) the acquisition alternative that will best achieve the stated goals must be selected. Mr. Gordon went on to delineate seven potential reasons for establishing a second source:

(1) broadening the production base

(2) evening out the fluctuation in the defense industry which leads to feast or famine situations for individual firms

(3) achieving savings through increased competition

(4) achieving superior equipment through increased competition

(5) facilitating NATO participation as co-producers or through offsetting co-production as subcontractors

(6) facilitating the attainment of socio-economic goals by increased award to minority and small business contractors, and,

(7) preserving competition for the sake of competition per se.

It is fully conceivable that some of these objectives may, in fact, be in conflict. If such is the case, a determination must be made as to the relative importance of said objectives so that those having the greatest impact may be considered as controlling.

Once the reasons for second sourcing have been established, this chapter presents a model which may be used by the Program Manager and/or the Contracting Officer in determining (1) whether or not the generation of a second source is feasible, and (2) which second sourcing methodology is best suited to the given acquisition situation. It is intended that this chapter be of sufficient breadth and depth that it can stand alone -- apart from the rest of the thesis. As a stand alone document, the chapter can be extracted from the thesis and used as a decision tool by program managers faced with second sourcing decisions. The Second Sourcing Method Selection Model (SSMSM) was developed jointly by this researcher and LCDR Dennis S. Parry, SC, USN who also utilized the model in his thesis entitled, "Second Sourcing in Major Weapon System Acquisition."

The following topics will be discussed in the remainder of this chapter: methods of generating a second source; variables affecting the second sourcing decision; and, the model itself -- including its format, the rationale behind the effectiveness factors incorporated therein, and a discussion of the actual use of the model.

B. METHODS OF GENERATING SECOND SOURCES

This section discusses five methods which can be used to provide two or more sources for second source production of a weapon system. Each method has advantages and disadvantages. The five methods to be described in the following pages are: form-fit-function, technical data package, directed licensing, leader-follower, and contractor teams. It should be emphasized that, where possible, the decision of whether or not to pursue second sourcing should be made as early as possible in the life of the program so that the development contracts can be structured to facilitate the technology transfer which is essential to production compitition. If the program manager waits until the design selection is made to consider production competition, he will probably encounter stiff and possibly insurmountable opposition from the "other half" of the bilateral monopoly which he has created.

1. Form-Fit-Function (F^3)

This method involves introduction of a second production source without need for a technical data package or for interaction between production sources. The second source is provided with functional specifications regarding such parameters as overall performance, size, weight, external configuration and mounting provisions, and, interface requirements. This is the classic "black box" concept where it is not necessary to define the internal workings of the product. It is used frequently for the acquisition of

expendable, non-repairable items where the ability of the system to perform as required is not dependent on what is inside the "box." The method does not work well where field level maintenance of the system is envisioned since the provision of non-identical items makes stockage of repair parts and training of maintenance personnel potentially insurmountable problems. These objections can sometimes be overcome by the use of warranty provisions, renewable maintenance contract provisions and/or provisions for contractor services to set up the necessary government maintenance capabilities to support the equipment throughout its lifetime. The advantages of acquisition by F^3 specifications include:

(a) Detailed design responsibility is clearly assigned to the contractor. If the item fails to meet specifications, the contractor must alter the design until specified operation is achieved.

(b) There is no design data package for the government to procure or maintain.

(c) Requirements for technical capability within the government are minimized. This is the path of least involvement on the part of the government in contracting, contract monitoring, etc.

(d) Standardization can be achieved among multiple sources through two-way interchangeability of products which may differ internally. These multiple sources may be exercised simultaneously.

The disadvantages include the following:

(a) Each procurement contains a development effort unless the product is off-the-shelf modified. Some time and money are involved each time the item is procured for engineering, changes, production learning curves, and debugging.

(b) Each time a procurement is made, the contractor who has the least appreciation for the total significance of the specification and the effort to accomplish the task is likely to be the low bidder. This means the source selection criteria must be very carefully constructed to include mechanisms to demonstrate contractor awareness of critical elements as well as his capabilities to produce the item.

(c) The costs of repair parts will tend to become excessive when a contractor realizes that he is in a somewhat sole-source position with respect to his equipment unless the total maintenance for the service life of the equipment is provided for in the procurement contract while competition is still being maintained.

(d) Careful specification of all external parameters is required to ensure true interchangeability. /15:vi-10/

2. Technical Data Package (TDP)

This method involves utilization of a stand alone technical data package to solicit proposals from manufacturers who may not have been involved in initial development of the system or in initial production. Ordinarily this is accomplished through the invocation of an appropriate data rights clause in the original R&D or initial production contract. Even where no such clause exists, it may be possible to buy the data package subsequent to production. In the absence of such a clause, the original developer/producer may consider the design, or portions of it, to be proprietary; and, hence, may be reluctant to provide a complete TDP to the government. The cost of procuring the data package subsequent to initial production may thus be prohibitive. This method assumes that the data package alone is sufficient to allow production of the system by alternate manufacturers. Although it has been successfully utilized, there are frequent examples where significant difficulties have been faced in applying the

method. Its chief attraction is that the existence of an adequate data package can result in the maintenance of a competitive environment throughout the life of the project.

Although theoretically sound, this method is perhaps the most hazardous of all the second sourcing methodologies. It is not well suited for use with highly complex systems or systems with unstable design or technologies. Experience has shown that drawings and specifications alone are often insufficient to secure effective transfer of manufacturing technology. "The critical factors may be craftsman's skills, ingenious processes, 'tricks of the trade', and esoteric shop practices that cannot be reduced to formal or informal paper." [8:83]

Once the data package has been accepted from the developer, the government effectively guarantees its accuracy and adequacy to the second source. If defects are subsequently discovered in the TDP, as is almost always the case, the second source may have the basis for a claim against the government. Some methods of minimizing this particular problem include: requiring the producer of the data package to certify its adequacy; pre-production evaluation by the second source; and, the use of latent/patent defects clause in the contract with the second source, to name a few. The use of a latent/patent defects clause, however, is experiencing significant disfavor, because it is being maintained by many legal representatives that the mere existence of such a clause is tantamount to governmental acknowledgement

of the inadequacy of the package. This puts the government in a precarious legal position in the event of subsequent claims.

There are other problems associated with the TDP approach. Although there are those who maintain that if the system was developed under government contract, there should be no proprietary rights to any of the data; the fact remains that much of the data required for successful technology transfer may be encumbered with claims that the information is proprietary. These problems center on the definition of "proprietary data" and "trade secrets" and on whether or not the government has the right to require the dissemination of such information. A complete discussion of these questions is beyond the scope of this study, however, they are discussed in detail in a Rand Corporation report by James W. McKie entitled "Proprietary Rights and Competition in Procurement." A 1975 report of the National Materials Advisory Board of the National Academy of Sciences entitled "The Effectiveness of the Army Technical Data Package in Technology Transfer for Procurement" provides valuable information regarding the use of the TDP as a vehicle for generating production competition.

The major advantages of second sourcing via the TDP include:

(a) The TDP can be used repeatedly in maintaining a competitive atmosphere throughout the production phase of the acquisition.

(b) Once the TDP is validated and proven adequate for production of the system, the mechanics of second sourcing are relatively simple. There need not be any contact between production sources and it is even possible to eliminate the original source altogether.

The primary disadvantages of the method are:

(a) It may be exceptionally difficult to obtain a complete and accurate TDP that is free of encumbrances and which, when followed, will yield a qualified product.

(b) The procuring authority must have access to whatever "in-house" talent is necessary to ensure resolution of data package problems.

(c) Even where drawings and specifications are complete and accurate, transfer of complex technology is often impossible without the benefit of engineering liaison between sources of production.

(d) Technological differences between companies (e.g., differing process methodologies) may be such that the second source does not have the capability of performance in accordance with the data package.

3. Directed Licensing (DL)

In its pure form, this method involves the inclusion of a clause in the early development contract allowing the government to reopen competition for follow-on production, select a winner, and appoint him as a licensee. Then, in return for royalty and/or technical assistance fees, the licensor (development contractor) will provide the licensee with manufacturing data and technical assistance to help the second source become a successful producer.

As used in some current acquisitions, licensing agreements are also being negotiated where no provision for such an agreement was included in the development contract. Such arrangements may, however, be considerably more costly

than those specified in the original development contracts. There has also been a trend toward allowing the licensor to choose his own licensee -- subject to government approval.

This method involves not only the transfer of data from the developer to the second source, but also provides for the transfer of manufacturing "know-how". The developer is normally awarded the first production contract and is contractually bound to licensing another contractor for production of an unspecified number of future systems. In fact, the provisions of the licensing agreement (including royalty fees; if any) should normally become one of the source selection criteria used in choosing the winning developer.

Directed Licensing seeks to solve technology transfer problems associated with the TDP methodology by providing for necessary engineering and manufacturing liaison between the sources which is then incentivized through the royalty procedure. It derives its attractiveness from the fact that subsequent reprocurements can be competed -- in whole or in part -- even where complex systems technology is involved. The technique of commercial licensing has been used successfully in industry for years, especially by firms desiring the sale of their products in foreign markets. In fact, more than 10,000 aircraft have been manufactured by companies that were not involved in the original R&D work. /7/

Promising as directed licensing may appear, it does entail the incursion of significant identifiable costs. If the royalty fee is unreasonable, the benefits of competing the production buy will be significantly reduced. If the developer can provide an acceptable product at a lower price than could a second source, however, the government need not actually exercise the licensing option. The mere threat of competitive options may be sufficient incentive for the developer to maintain efficiency and keep costs to a minimum.

For a more detailed discussion of directed licensing, examination of the Rand Corporation report by Gregory A. Carter entitled: "Directed Licensing: An Evaluation of a Proposed Technique for Reducing the Procurement Cost of Aircraft" [1] is invited. In 1969, the General Accounting Office (GAO) performed an evaluation of the feasibility of implementing directed licensing. The resultant report [21] cites several potential problems with the technique and concludes that directed licensing would not provide a workable solution to the problem of reducing the cost of major systems. The potential problems cited by GAO are addressed in the Carter article and are considered critical to understanding and evaluating and the potential effectiveness of directed licensing.

The advantages of directed licensing includes:

(a) The potential for production competition is maintained throughout the acquisition cycle.

(b) The government need not become closely involved with the actual transfer of technology between sources.

(c) Quantity production decisions and source of supply decisions can be postponed until later in the acquisition process.

(d) The designer is provided with protection as to how, or in what markets, the second source is to be licensed to sell the product; and, the designer may be compensated for each item produced by the second source.

The disadvantages of directed licensing include:

(a) The existence of royalty and technical assistance fees increases the cost of the acquisition and could be prohibitive.

(b) It may be difficult to achieve the necessary degree of cooperation between alternative production sources, and the licensee may have little recourse against half-hearted cooperation on the part of the licensor.

(c) Some contractors may bid on projects simply to obtain proprietary information on other producers' designs.

(d) It may become difficult to maintain design accountability.

4. Leader-Follower

The DAR defines leader-follower as "an extraordinary procurement technique under which the developer or sole producer of an item or system (the leader company) furnishes manufacturing assistance and know-how or otherwise enables a follower company to becoma a source of supply for the item or system." DAR limits the use of this technique to situations when all of the following conditions are present:

(a) the leader company possesses the necessary production know-how and is able to furnish requisite assistance to the follower;

(b) no source of supply (other than a leader company) would be able to meet the government's requirements without the assistance of a leader company;

(c) the assistance required of the leader company is limited to that which is essential to enable the follower company to produce the items; and

(d) the government reserves the right to approve contracts between the leader and follower companies.

DAR suggests the following three methods for establishing a leader-follower relationship (no preference is indicated as to which method should be used):

(a) One procedure is to award a prime contract to an established source (leader company) in which the source is obligated to subcontract a designated portion of the total number of end items required to a specified subcontractor (follower company) and to assist the follower company in that production.

(b) A second procedure is to award a prime contract to the leader company for the requisite assistance to the follower company, and another prime contract to the follower company for production of the items.

(c) A third procedure is to award a prime contract to the follower company for the items, under which the follower company is obligated to subcontract with a designated leader company for the requisite assistance.

Leader-follower procurements have been undertaken in the past more for the purpose of meeting delivery schedule requirements due to the lack of capacity of a single source, rather than for increasing competition. However, since the concept encompasses dual or parallel production lines, splitting the award quantity on a high-low percentage basis would still insure a significant degree of competition for the annual production contracts.

The advantages of leader-follower are similar to those of directed licensing in that:

(a) It provides a technique for transferring part or all of the production of a complex system to a second source.

(b) Competition can be utilized to determine the acquisition split award to each qualified producer even when two sources are maintained throughout the acquisition cycle.

(c) It has been used successfully in the past.

The major disadvantage of the leader-follower technique is that "leader" companies may be less enthusiastic about this technique than directed licensing because leader-follower contains no royalty provisions for proprietary data nor does it provide some of the protection that may be present in a licensing arrangement.

5. Contractor Teams

A recent innovation in the generation of production competition is represented by the contractor teams which are currently competing in the design selection phase of the Airborne Self-Protection Jammer (ASPJ) system. In the solicitation for the design of the ASPJ, the Naval Air Systems Command (NAVAIR) required that offerors form teams of two or more contractors. This acquisition strategy envisions the award of a production contract to the team which eventually wins the design competition. Following initial production, both contractors are expected to have the capability to produce the complete system. DAR provides a brief discussion of contractor teams including a policy statement on the use of teaming arrangements. The implication of DAR is that the government will generally permit contractor teams, but it does not mention actions by the government to require the

formation of teams as was done on the ASPJ. DAR does mention that some contractor teaming arrangements may violate anti-trust statutes. The program manager and/or the contracting officer must be sensitive to this possibility in order to prevent its occurrence.

The advantages of requiring contractor teams are:

(a) It should prevent most of the problems in qualifying a second source, since at least two contractors were involved in the design and initial production.

(b) It should also reduce or eliminate the feeling on the part of either contractor that trade secrets or proprietary data are being given away to outside sources.

(c) No liaison fees or royalties will be involved in the establishment of the second source.

(d) The design talent of two contractors will be brought to bear on each proposal, thereby increasing the opportunity for successful and innovative designs.

(e) It provides a vehicle for increasing the capacity of the industrial base.

The disadvantages of contractor teams are:

(a) The design phase may be more costly since at least two contractors are involved on every proposal.

(b) It requires a great deal of cooperation and coordination by the contractors.

C. VARIABLES AFFECTING THE PRODUCTION COMPETITION DECISION

The selection of the "best" method for generating production competition will vary depending on a number of factors extant in any acquisition program. The existence of these factors (i.e., decision variables) presents the program manager with a difficult, multi-faceted decision situation. He must consider the strengths and weaknesses of each

competitive method in relation to the influence of the variables in his acquisition program.

In order to assist the program manager in logically and systematically selecting the optimal competitive method, an evaluative model is needed. The model should rank each of the competition techniques against each of the decision variables. Then, by objectively evaluating the influence of each of the variables, the program manager will be led to an optimal choice of which method of competition to use in his program. At a minimum, one or two methods may be shown to be clearly superior to the others, thereby reducing the complexity of the decision situation.

The next section presents such a model. Before describing the model, however, it is necessary to define the decision variables on which the model is based and to describe the general impact which each of the variables has on the feasibility of production competition.

SECOND SOURCE DECISION VARIABLES --

1. <u>Quantity to be Procured</u>

The ultimate quantity to be procured and the rate at which the government will place orders for production will have a significant effect on the adaptability of the project to second sourcing. In general, the larger the quantity to be procured, the more feasible it is to have production competition. The ideal situation for second sourcing would entail large quantities needed at a rapid rate over a number of years. Any deviation from this ideal

will tend to lessen the cost effectiveness of generating a second source.

2. Duration of Production

As alluded to above, it is generally true that the longer the duration of the projected production, the more feasible second sourcing becomes. For example, suppose the production phase is to be only four years long, and it takes at least two years to bring a second source on line (including source selection, start-up of the plant, and production of a learning/qualification quantity). In this case, there would be only a year or so left for production of the system by the second source, in which case second sourcing would be an inappropriate strategy.

3. Slope of the Learning Curve

The flatter the slope of the learning curve, the more adaptable the project becomes to second sourcing. With a steep learning curve, the more units produced by the original source before a second source is brought "on-line", the more unlikely it becomes that the second source can effectively compete with that original producer who is, by then, a more experienced and efficient producer.

4. Complexity of the System

The more complex the system, the more essential is the need for cooperation and liaison between the two production sources, and the less adaptable is the project to second sourcing.

5. State-of-the-Art

If the technology employed in the system is at the leading edge of (or advances) the state-of-the-art, it becomes unlikely that a second source will be able to produce the system without significant difficulties -- probably necessitating significant cooperation between original and second source producers.

6. Other Potential Government or Commercial Applications

If the system has wide applicability for other government or commercial uses, the original developer is more likely to demand some form of protection for his "trade secrets" or "proprietary data" than if the market for the product is very limited. On the other hand, the interest of potential second sources in the project will be stimulated if other applications for the hardware exist.

7. Degree of Privately Funded R&D

The greater the degree of privately funded R&D on which the design is based, the more reluctant the developer will be to release his design to a second source. This is particularly true if no restrictions are placed on the use of the design by that second source.

8. Cost of Unique Tooling/Facilities

As special tooling/facilities requirements and costs increase, the number of potential second sources decreases and probability of being able to bring a second source on line in a cost effective manner decreases. Also pertinent will be other start up and non-recurring costs,

including first article acceptance testing. The higher these costs become, the more difficult it is to amortize them over the duration of the acquisition.

9. Maintenance Concept to be Employed

Second sourcing, with its multiple producers, can have significant impact on the maintenance considerations of the system. Whenever two systems of the same type are non-identical, the ability to support those systems with field level repair parts and maintenance personnel becomes diluted.

10. Cost of Transferring Unique Government Owned Tooling/Equipment

If any unique government-owned tooling is difficult or expensive to transfer from one contractor to another, it may be necessary to provide duplicate sets of tooling in order for a second source to become a viable competitor. The cost of transferring tooling, then, can work in the same manner as the cost of the tooling itself in inhibiting the adaptation of the project to second sourcing.

11. Contractor Capacity

If the original producer does not have the ability to produce needed quantities of the system according to the required delivery schedule, development of a second source may become mandatory. Lack of adequate capacity may thus be considered a controlling factor in deciding for second sourcing. If, on the other hand, the original producer has sufficient or even excess capacity, reduction in the production quantities awarded may significantly increase the costs of production through increased overhead.

12. Production Lead Time

The longer the production lead time, the longer it will take to bring a second source in line and the less appealing becomes the second sourcing option.

13. Contractual Complexity

The more complex the original production contract (e.g., Life Cycle Cost parameters, Design to Cost considerations, Warranty Agreements) the less adaptable to second sourcing the project becomes. With warranties, for instance, it may be necessary to keep two sources capable of performing warranty work throughout the life of the project -- even though a production buy-out may have been exercised at some point in the acquisition.

14. Amount and Type of Subcontracting

If the number of qualified subcontractors is limited and the degree of reliance on those subcontractors is necessarily heavy, the benefits to be realized through second sourcing are necessarily lessened.

D. THE MODEL

The Second Sourcing Method Selection Model (SSMSM) shown on the following pages is heuristic in nature. Its objective is to provide a logical and systematic framework for evaluating the applicability of each of the competitive methods in light of the variables present in the acquisition situation. The end result of the evaluation process will (at best) be the selection of the optimal competitive technique. At worst, use of the model should serve to eliminate one or more techniques

from further consideration. In that case, the decision situation will have been simplified and certain variables should emerge as being critical, thereby, suggesting the areas which need further investigation and/or consideration.

1. Format of the Model

It should be noted that the model is actually two models. The pre-production model (page 67) is for use by the program manager who is developing his overall acquisition strategy. In other words, the program second sourcing decision is being made at some point prior to DSARC II. The post-production model (page 68) is for use by a program manager who is already in the production phase of the program and is considering the generation of a second source for part or all of the remaining life of the acquisition. It is necessary to differentiate between the two situations because the effectiveness factors assigned to each of the methods change significantly depending upon whether the second sourcing decision is being made early or late in the program's life cycle.

The SSMSM lists the fourteen decision variables vertically on the left. Each of these variables is divided into two or three categories (e.g., high-medium-low, yes-no) to allow the model to be tailored to the refinements of a given acquisition situation. Across the top of the model are listed the second sourcing methodologies. It should be noted that the five methods, (F^3, TDP, DL, LF, and CT), when placed in that order, represent a line of continuum with respect to

the degree of cooperation and contact needed between the original developer and the second source. For example, second sourcing on the basis of F^3 or TDP involves no need for contact between the two contractors. At the other extreme is CT which representa a formal alliance between two or more contractors. Recognizing this relationship among the methods provides a better understanding of the way each method relates to the variables and to the other methods. Understanding this relationship may even lead to effective modification or hybridization of the techniques not previously considered.

2. Effectiveness Factors

The model rates the effectiveness of each of the methods with respect to each of the decision variables. A simple three point system of "+", "0", or "-" is used to denote whether a given method is particularly strong, neutral, or weak with respect to each of the variables. In addition, an "X" is used to denote a situation where the use of a given method is particularly inappropriate, or, to caution that particular care should be used in applying a given method in that situation. A "*", on the other hand, indicates that the method is particularly well suited to the situation under consideration.

The three point system is used because of the non-quantifiable nature of the model. A wider scale (-5 to +5, for example) would merely invite argument over the rankings assigned and would detract from the main purpose of the

model. The primary value of the model is that it serves as a guide to the subjective decision process and that it gives recognition to the differences among the methods. It is not intended to provide an elaborate quantification scheme which removes the need for experience and judgment.

E DISCUSSION OF THE MODEL'S WEIGHTINGS

1. Quantity

Low production quantities make successful second sourcing difficult, at best. None of the methods will work well under such circumstances. By the time the second source is qualified as a producer, the savings potential on the remaining quantities will probably not justify the associated expense. In the post-production phase, the difficulties usually associated with the qualification of a second source through the use of a TDP make that method especially undesirable; whereas, the relative simplicity of the F^3 technique yields the greatest probability of success when low quantities are involved. Only where the magnitude of the system and its price are truly significant will small quantities justify the use of the DL, LF, or CT methods. As quantities rise, the viability of all the methods increases. Because there is a dilution of the total quantities to be produced subsequent to initial production, the pre-production portion of the model appears slightly more favorable than the post-production portion with respect to quantity.

2. Duration of Production

The rationale provided in the discussion on quantity also pertains to the duration of production variable. Any attempt to qualify a second production source will take time, and the likelihood of success decreases as the time required for the qualification of a second source increases. DL and LF techniques are therefore especially unsuitable since both assume original production by the development contractor.

3. Slope of the Learning Curve

If the demonstrated learning curve of the original producer is flat, all methods are worthy of consideration. Where steep learning is exhibited, the original producer will experience a significant competitive advantage for future awards; and, if cost savings is the object of the second sourcing effort, it may be extremely difficult to justify going to an alternative source. It should be noted, however, that a steep learning curve might also indicate that the base price was unrealistically high in the first place -- resulting in an unjustifiably inflated original award.

4. Technical Complexity

DL, LF, and CT are techniques that are designed to provide the necessary liaison and cooperation to assure effective transfer of even highly complex technology. CT is especially effective under such circumstances since the teams can be constituted such that complementary technologies can be brought together. When production by an original source has begun, CT, in the pure sense is not possible, however,

a team of competitors might be attracted to vie for follow-on production contracts. Problems with TDP's are often insurmountable without costly and labor intensive effort when high levels of technology are involved. It is not impossible to use this method in such cases, however, extreme care must be exercised to ensure the adequacy of the data package and to ensure the choice of a second source which is likely to be capable of overcoming data package problems. The simpler the system, the more probable becomes the success of all the methods.

5. State-of-the-Art

The same rationale provided for the technical complexity factor applies to the state-of-the-art variable. The more liaison between the production sources, the greater is the chance of successful technology transfer. Transfer of state-of-the-art technology by data packages alone is virtually impossible.

6. Other Government and Commercial Applications

Where there are expected to be significant alternative uses for the system, the original producer may be expected to claim or generate legal or quasi-legal barriers (patents, trade secrets, proprietary data) to the dissemination of his design unless he is handsomely compensated or is given specific protection in the form of limitations placed on the use of his design. DL provides royalty payments to the developer/original producer; F^3 does not require the transfer of data; and CT arrangements specify that both

members of the team will be capable of producing the end item so these methods facilitate the award of alternate follow-on production contracts. With a TDP, the post-production use of the method is less attractive since the original producer will usually have proof of alternative uses rather than conjectured alternatives.

7. Degree of Privately Funded R&D

If the contractor's privately funded R&D led to the development of a design that the government selects for production, it is almost certain that a significant amount of proprietary data will be included in the design package. In such a circumstance, he is likely to vehemently resist any attempt to disseminate that information. With DL and CT methodologies his rights will be protected or he will receive compensation for the use of his data so his resistance will be somewhat less violent. Although it is difficult to imagine a situation wherein all the R&D would be privately funded, the existence of a single critical process that is truly proprietary will greatly lessen the chance of second sourcing success.

8. Special Tooling Costs

When the cost of special tooling is significnat, the willingness of potential competitors to enter the market -- without provision of government-owned tooling or unless the quantity and duration of production is sufficient to allow ammortization of the costs of such tooling -- is limited. Regardless, the original producer will have a real competitive advantage where high tooling costs are included. Even

where the tooling is government-owned, the potential disruption associated with the transfer of the tooling may be unacceptable -- requiring duplicate tooling to be provided. A contractor teaming arrangement, subsequent to initial production, might result in the need for three separate sets of tooling -- making such an arrangement particularly unpalatable.

9. Cost of Transferring Unique Government-Owned Tooling

Shifting of production units from one source to another implies one of two alternatives: (1) shifting the government-owned tooling, or, (2) providing additional -- perhaps excess -- capacity in the form of duplicate tooling and equipment. Of course, where mobilization base considerations are controlling, the latter is mandated. Also, where the cost of buying duplicate tooling is less than or equal to the cost of transferring the tooling from year to year (including disruption costs), this variable may be eliminated from consideration. Since the cost of transferring tooling and equipment has an equivocal affect on all methodologies, the weighting assigned to each is identical.

10. Capacity of the Developer/Original Producer

When the original producer does not have sufficient capacity to allow him to manufacture the desired system in required quantities, at required quality and to deliver those systems in accordance with the prescribed schedule, any of the methods may be considered. Where sufficient or excess capacity exists with the original producer, it may be more costly (especially in the short run) to second source than

it is to remain with the original source alone. Cutting the quantities awarded to a source, with existing excess capacity, usually means that the fixed overhead must still be spread over the now lower quantities -- yielding higher prices.

11. Maintenance Requirements

Where field level maintenance needs are relatively insignificant, second source production presents little or no problem. As the need for field maintenance increases, however, the non-identical nature of second sourced systems becomes more difficult to accomodate. F^3 systems usually exhibit the least degree of commonality and therefore cause the most severe maintenance and support problems.

12. Production Lead Time

The longer the lead time associated with the production of the system, the more difficult it becomes to bring alternative producers on line early enough to realize the potential advantages of second sourcing. This holds true regardless of the second sourcing method chosen.

13. Contractual Complexity

The more complex the contractual relationship between the original producer and the government, the greater are the barriers to successful second sourcing. Life Cycle Cost parameters, Reliability Improvement Warranties and other contractual complexities become difficult to enforce when dealing with multiple sources. In fact, the cost of maintaining multiple source warranties may become prohibitive.

14. Degree of Subcontracting

Where there is a great deal of subcontracting or where the number of firms capable of performing subcontracting functions is limited, the advantages of second sourcing the prime contract will be diluted. Given the fact that the primes may be forced to compete for the services of the same subcontractors, or use the materials of a single supplier, the prices may even rise with second sourcing.

F. USE OF THE MODEL

As stated earlier, the model is not designed to be a strictly quantified decision-making device wherein the evaluation factors for each method are summed and the method with the highest "score" is selected. The correct use of the model requires the use of judgment at every step. The first (and possibly most difficult) step is to evaluate the acquisition situation in terms of the decision variables (that is, to determine whether the acquisition will cover high, medium, or low quantities; whether technical complexity is high, medium, or low; and to make similar judgments about the other variables). The program manager is encouraged to add new variables to the list as he sees the need for them. The next step is to evaluate the second sourcing methods in relation to the variables which exist in a program -- realizing that some variables will be more important than others. One method may turn out to dominate all the others or there may be more than one feasible method. Additional judgment will, therefore, be required. It may even be possible to allow

the competing contractors to have an input to the decision process. If the model can simplify and guide the thought process so that: (1) all significant variables are recognized and objectively evaluated, (2) clearly inappropriate second sourcing strategies are eliminated, and (3) an appropriate method is selected, then the model will have served its purpose.

SECOND SOURCING METHOD SELECTION MODEL (PRE-PRODUCTION)

Variables		F^3	TDP	DL	L-F	CT
			Methodology			
Quantity	High	+	+	+	+	+
	Medium	+	+	0	0	+
	Low	0	0	-	-	0
Duration	Long	+	+	+	+	+
	Medium	+	+	0	+	+
	Short	0	0	X	X	0
Learning Curve	Steep	-	-	-	0	0
	Flat	+	+	+	+	+
Technical Complexity	High	0	X	+	+	*
	Medium	+	-	+	+	+
	Low	+	+	+	+	+
State of the Art	Yes	0	X	+	+	*
	No	+	+	+	+	+
Other Application	Yes	+	0	+	0	+
	No	+	+	+	+	+
Degree of Private R&D	High	0	X	0	X	-
	Low	+	0	+	+	+
Tooling Costs	High	-	-	-	-	X
	Low	+	+	+	+	+
Govt. Tool Transfer Cost	High	0	0	0	0	0
	Low	+	+	+	+	+
Contractor Capacity	Excess	-	-	-	-	-
	Deficient	+	+	+	+	+
Maintenance Requirement	Significant	X	0	0	0	0
	Minimal	+	+	+	+	+
Production Lead Time	Long	-	-	-	-	-
	Short	+	+	+	+	+
Degree of Subcontracting	Heavy	0	-	-	-	-
	Light	+	+	+	+	+
Contractual Complexity	Complex	-	-	-	-	-
	Simple	+	+	+	+	+

SECOND SOURCING METHOD SELECTION MODEL (POST-PRODUCTION)

Variables		Methodology F^3	TDP	DL	L-F	CT
Quantity	High	+	+	+	+	+
	Medium	+	0	0	0	0
	Low	0	X	-	-	-
Duration	Long	+	+	+	+	+
	Medium	+	0	0	0	0
	Short	0	X	X	X	-
Learning Curve	Steep	0	0	0	0	0
	Flat	+	+	+	+	+
Technical Complexity	High	0	X	+	+	+
	Medium	+	-	+	+	+
	Low	+	+	+	+	+
State of the Art	Yes	0	X	+	+	*
	No	+	+	+	+	+
Other Application	Yes	+	-	+	0	+
	No	+	0	+	+	+
Degree of Private R&D	High	0	X	0	X	0
	Low	+	0	+	+	+
Tooling Costs	High	-	-	-	-	X
	Low	+	+	+	+	+
Govt. Tool Transfer Cost	High	0	0	0	0	0
	Low	+	+	+	+	+
Contractor Capacity	Excess	-	-	-	-	-
	Deficient	+	+	+	+	+
Maintenance Requirement	Significant	X	0	0	0	0
	Minimal	+	+	+	+	+
Production Lead Time	Long	-	-	-	-	-
	Short	+	+	+	+	+
Degree of Subcontracting	Heavy	0	-	-	-	-
	Light	+	+	+	+	+
Contractual Complexity	Complex	-	-	-	-	-
	Simple	+	+	+	+	+

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The following conclusions can be drawn from the research:

* It is clear that the concept of competition enjoys a high degree of support from a wide range of advocates. In order to successfully incorporate competition into an overall Acquisition Strategy, however, the program manager must understand what constitutes effective competition in both the design and production phases of his acquisition program.

* The current acquisition instructions address the subject of design competition in considerable detail. The instructions specify the reasons for, and the general approach that should be taken in the generation of design competition. However, the instructions fail to distinguish between design and production competition. They allude to the concept of production competition only in vague and very general terms. No guidance is provided as to the advantages or problems associated with obtaining a second production source, the methods available for generating a second source, or the decision-making process by which a second sourcing method should be selected.

* Second Sourcing may not be appropriate for all acquisition programs, particularly those with short production lives and/or low production quantities. However, where it is feasible, the establishment of a second source may provide substantial benefits to the government, such as:

(a) Broadening the production base.

(b) Cost savings from production competition, possibly in the billions of dollars per year.

(c) Smoothing out the fluctuation in the defense industry which leads to feast or famine situations for individual firms.

(d) Achieving superior equipment through increased competition.

(e) Facilitating NATO participation as co-producers or through offsetting co-production as subcontractors.

(f) Facilitating the attainment of socio-economic goals by increased award to minority and small business contractors.

(g) Reducing the propensity for buy-ins.

(h) Disengagement of some government controls from the contractural relationship.

* Decisions regarding both design and production competition should be made as early as possible in the acquisition cycle and incorporated as an integral part of the Acquisition Strategy.

* Contractors should be informed early in the process of the government's intentions relative to both design and production competition.

* In some cases the cost-saving potential of production competition may be achieved without actually having to bring a second source on-line. The mere existence of a <u>viable</u> method for transferring part or all of the production to a second source may be sufficient to insure that the government receives the system from the original producer at a fair and reasonable price.

* The generation of a second source, for whatever reason, has several problems, or potential problems, associated with it, such as:

(a) Additional front-end costs

(b) Willingness of contractors to participate

(c) Potential for unqualified contractors to buy-in and subsequently to default

(d) Program stretch-out

(e) Maintenance of the data package/coordination of ECP's

These problems can be either eliminated or minimized, however, by proper advance planning, early and forthright communication with the contractors, and selection of an appropriate second sourcing method.

B. RECOMMENDATIONS

As a result of this research, the following recommendations are offered:

* The Office of the Secretary of Defense (OSD) and the Office of Federal Procurement Policy (OFPP) should revise their major policy statements (DOD Instructions 5000.1 and 5000.2 and OMB Circular A-109) to include formal recognition of the independent concepts of design competition and production competition. Program managers should be directed to include both types of competition in their acquisition strategies whenever it is feasible and appears economically beneficial to do so.

* Additional guidance should be provided to program managers in a separate instruction or by publication of a

desk-guide relative to the subject of second sourcing and production competition. In order to provide this additional guidance, OSD should conduct a study which includes:

1. A review of several past acquisition programs which have either successfully or unsuccessfully pursued second sourcing/production competition. The predictive ability of the SSMSM should be tested on these programs on an after-the-fact basis.

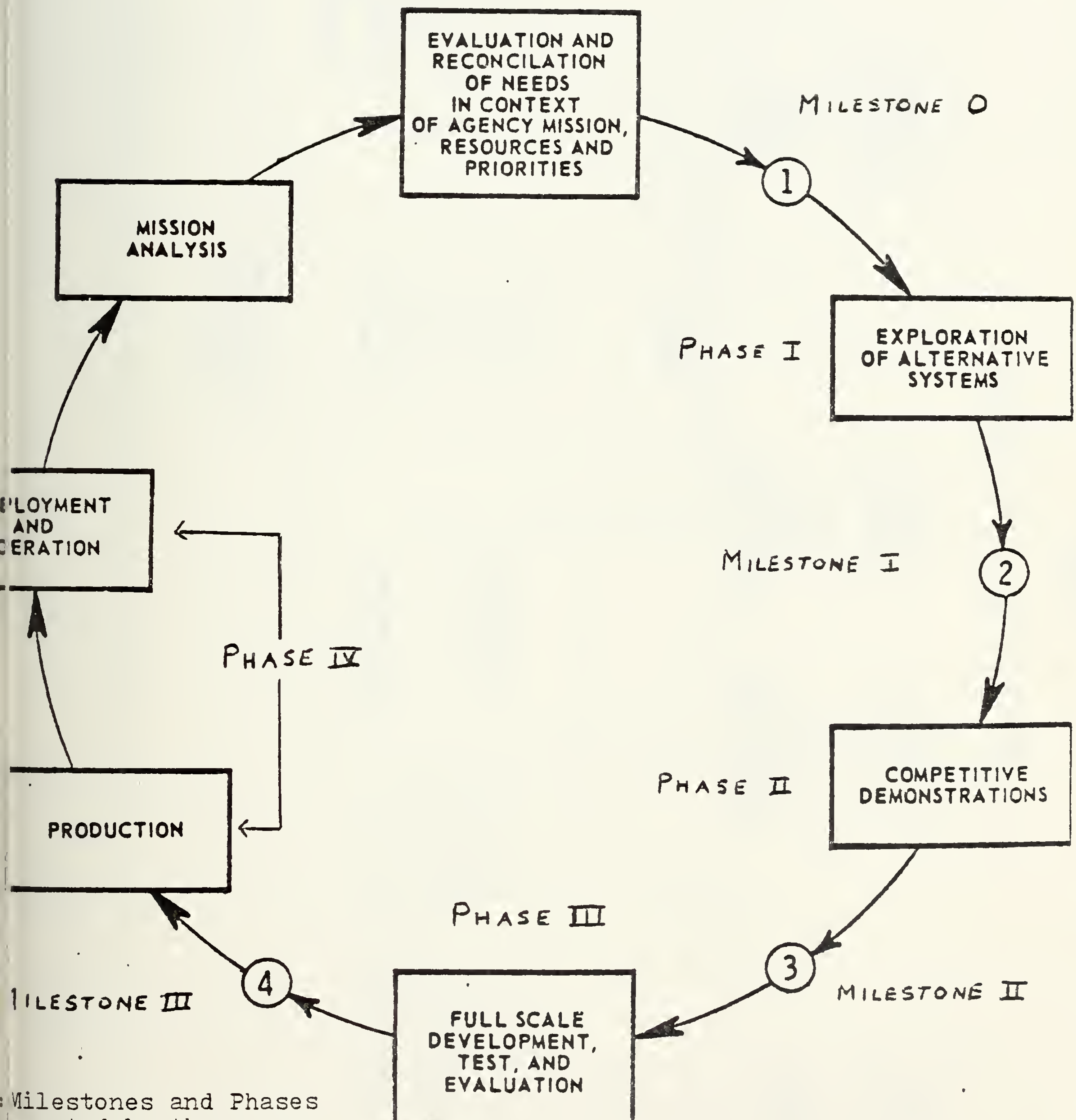
2. Distribution of this thesis (or Chapter V at a minimum) to several program managers in each of the services who are currently involved in either the planning or the execution of second sourcing/production competition decisions. These program managers should be directed to evaluate the applicability and usefulness of the SSMSM and to provide feedback to OSD in the form of modifications or additions which would improve the usefulness of the model.

The formulation of the new instruction or desk-guide referred to above should incorporate the knowledge gained from the study described above.

* The Decision Coordinating Paper in support of DSARC I should specifically address the methods selected for generating both types of competition, or the reasons for a determinination of the infeasibility of either type. Decision Coordinating Papers for subsequent Milestones should address any significant deviation from the selected approach.

FIGURE 1.

MAJOR SYSTEM ACQUISITION CYCLE



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nserted by the
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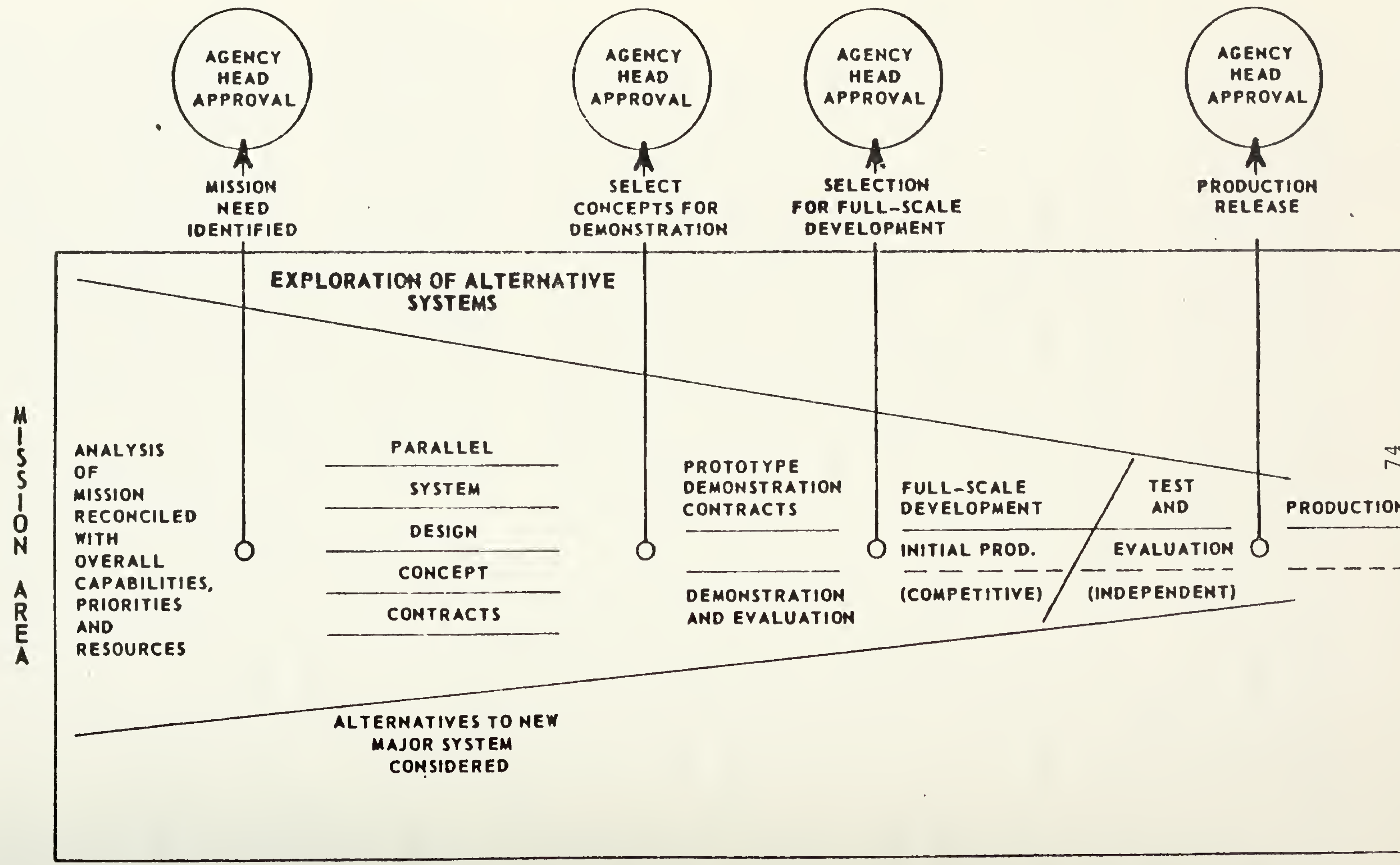
aability with the text.

Source: Reference 16

FIGURE 2

MAJOR SYSTEM ACQUISITION PROCESS



APPENDIX B

ACQUISITION STRATEGY (excerpted from OFPP Pamphlet No.1)

One of the program manager's first tasks will be to develop an acquisition strategy. The purpose is to get the program manager, with his team, to think through the acquisitions process and the myriad of individual considerations, and then join them to achieve his program objective in an economical, effective, and efficient manner.

In developing a system acquisition strategy considerable thought should be given to speicifc program goals and objectives. The approach should not be reduced to fill-in-the blank formats or cookbooks.

The strategy should form the basis for the program manager's system acquisition plan. He should then use his plan to communicate with higher authority, his management team, interfacing government organizations, and industry. The plan should also provide the means to measure accomplishments and consider contingencies as the program progresses. At program initiation, it is neither possible nor desirable to address all considerations in detail. It is possible and desirable, however, to examine and schedule when decisions on each consideration can and must be made throughout the acquisition process and to refine the strategy and planning as the program proceeds.

The plan should encompass the entire system acquisition process with emphasis on the near term time phased actions. As the program proceeds and periodic reviews are made, the

next increment of near term considerations should be emphasized. Such an approach minimizes the planning burden and provides a basis for program direction and for measurement of success against program goals and objectives.

Circular A-109 includes policies and some typical considerations that should be addressed in the development of a strategy and then reflected in a system acquisition plan. For example: the general policy to rely on the private sector in accordance with OMB Circular No. A-76; the use of contracting as a tool in the acquisition process and not as a substitute for management; the use of competitive parallel short-term planned dollar value contracts for well-defined work activities during exploration of system design concept alternatives; and preclusion of nonessential reporting procedure and paperwork requirements being placed on contractors.

There are many other necessary considerations not included in Circular A-109 that need to be addressed by a program manager. For example, the favorable and unfavorable lessons learned from similar acquisitions. Still others may be grouped in categories such as; system/product development, business management and program management.

Some system/product development examples include: recognition of and accommodations for risks and uncertainties that assures proper relationship of risk sharing between Government and contractors; the Government tailoring of specifications and standards in consonance with contractors' efforts and the time phased introduction of the results into

the acquisition process (the objective being to avoid non-essential constraints on either prime or subcontractors); the Government providing guidelines for contractor development of performance specifications for full scale development and product specifications for production; and the optimal use of government laboratories in furnishing technical direction to the contractors during system development.

Some business management examples include: obtaining and sustaining competition, including high cost subsystems which may be proposed; accommodating procurement lead times; precluding technical transfusions and "auctions" in the proposal evaluation, source selection, and negotiation process; and providing contractually for proposal submittals for the next planned increment in the acquisition process.

Some program management examples include: selection of a project management organizational mode such as vertical or matrix; the appropriateness and applicability of incremental approvals of contractors efforts throughout the acquisition process; and the applicability of Government policies for standardization and interoperability with systems of friendly countries.

In conjunction with the development and tailoring of an acquisition strategy, the program manager should establish an analysis structure and decision mechanism to handle both short-term considerations for system acquisition management.

APPENDIX C

This Appendix is an excerpt from a November 1973 study performed by the Logistics Management Institute entitled "The DOD-Contractor Relationship." In the opinion of this researcher, this segment of the study argues so eloquently and forcefully for the use of production competition that it is more meaningful to include several pages directly from the study than to attempt extensive paraphrasing of the text.

3. Cost Based Profits

The ASPR is clear on the importance of profit in the structure of the DOD-Contractor relationship:

> It is the policy of the Department of Defense to utilize profit to stimulate efficient contract performance. Profit generally is the basic motive of business enterprise.[1]

The method used to apply the profit motivation in negotiated contracts has been to base profit objectives on the estimated cost of contract performance. There are those who feel that the principle communicated to contractors has been: The higher the costs, the greater the profit dollars that will be accepted by the government buyer.

The basing of profit on costs is more explicitly stated in the weighted guidelines method introduced into ASPR in 1963.[2]

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[1] ASPR 3-808.1(a). (Underscoring added).

[2] ASPR 3-808.2.

The four major profit factors are applied to specific items of costs or to the total estimated cost of performance. Prior to 1963, under ASPR policies dating back to the Armed Services Procurement Act of 1947, although fee limitations were stated in terms of percentages of cost, profit was not so explicitly keyed to costs. Nevertheless, the base of costs on which the selected profit percentage was applied was one of the most significant factors affecting the profit objective.[1] Indeed, the history of deriving profit by applying an essentially fixed percentage to estimated costs of performance was one of the reasons for the introduction of the weighted guidelines method.

The current test of a policy basing some part of the profit objective on a contractor capital employed reflects an effort to move away from the base of costs. For valid reasons, one-half of the profit objective will continue to be based on costs.[2] Nevertheless, to the extent that profit is a motivating influence a policy which bases profit on costs does not encourage contractor efforts to reduce costs. If a contractor reduces direct costs, he reduces the cost base on which profits

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[1]LMI, Study of Profit or Fee Policy, Project 5B1, January, 1963, pp. 42-43. (AD 472065)

[2]Defense Procurement Circular No. 107, December, 1972, pp. 4-15

on follow-on contracts will be negotiated. If a contractor reduces overhead costs, he reduces the base for all future contracts.[1]

There is empirical evidence that cost-based pricing leads to excessive labor and higher costs. Arditti and Peck found that the aircraft industry had, in fact, a significantly lower labor elasticity than industries subject to conventional pricing constraints. More labor was retained during periods of sales declines, with implications of far-reaching consequences for cost growth:

> An excess labor supply is unlikely to be actually idle; rather it is at work. The resulting work requires additional materials, subcontracting, and even complementary labor.
>
> . . . .
>
> One might argue that the resulting work ought to be counted as a positive blessing of excess labor, which offsets its extra cost. But the use of such workers may lead to an entire style of development that overemphasizes complexity and maximum performance, and disregards costs and timeliness. This development style is hardly reversible as the cycle of weapons industry sales proceeds. The long run costs of lower labor elasticity, then, may not be those measured here, but rather its contribution to a markedly nonoptimal development style.[2]

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[1]This effect has probably had much to do with the failure of incentive contracts to motivate contractors to reduce costs on given contracts. See, for example, Irving N. Fisher, A Reappraisal of Incentive Contracting Experience, RM-5700-PR (Santa Monica: The RAND Corporation, July, 1968), and John M. Parker, Jr., An Examination of Recent Defense Contract Outcomes in the Incentive Environment, (Dayton, Ohio: AFIT, September, 1971). (AD 731764)

[2]Fred D. Arditti and Merton J. Peck, Cost-Based Pricing and Labor Elasticity, P-3438-1 (Santa Monica: The RAND Corporation, September, 1967), p. 22.

The most explicit statement we have found on the motivational effect on a cost-based profit policy was made by Mr. Clarence "Kelly" L. Johnson, Senior Vice President, Lockheed Aircraft Corporation:

> Now if the Skunk Works thing has been so good, why don't more people use it?...Fewer people are required, therefore the profit is less. Say what you want, I don't care what form of contract you've got, if it takes a raft of people, you make more money.[1]

In the commercial marketplace, private enterprise firms -- which are profit maximizers (seeking the highest possible return to their stockholders), and which compete with each other in price competitive markets -- ideally assure the attainment of maximum economic efficiency.[2]

However, many firms are not competitive profit maximizers. H.T. Keplin has pointed out that the failure of the firm to maximize profits will usually indicate the existence of economic inefficiency.[3] O.E. Williamson has

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[1] National Security Industrial Association, Seminar on Prototyping, 23-24 February 1972, p. 38.

[2] This is a well accepted point of economics and several empirical studies substantiate it: David R. Kamerschen and Richard L. Wallace, "The Costs of Monopoly, in the Anti-trust Bulletin, Vo. XVII, Number 2 (Summer 1972), pp. 485-496. David R. Kamerschen, "An Estimation of the 'Welfare Losses' from Monopoly in the American Economy," Western Economic Journal, 4 (Summer 1966), pp. 221-236.

[3] H.T. Keplin, "The Profit Maximization Assumptions," Oxford Economic Papers, 15:2 (July, 1963), pp. 130-139.

provided a detailed theory of the inefficiency arising from behavior not directed at profit maximization and has analyzed a number of historical cost studies in which great profit improvements and reductions in waste were obtained by re-orienting the objectives of management.[1]

Many firms are no longer controlled by their owners. Berle and Means were the first to recognize the implications of the separation of ownership and control.[2] Although management may attempt to obtain enough profit to provide for a reasonable and gradually increasing dividend, it is free to pursue other objectives rather than concentrating on profit maximization. These other objectives may be sales growth, the growth of management teams, the pursuit of managerial emoluments, or the minimization of risk. Profit maximization yields no particular utility to professional managers, who do the work but collect only a fraction of the dividends.

> On the other hand, management could be concerned with maintaining the firm's market position, adding to the firm's sales revenue, or increasing the total assets controlled by the firm. This could be the case when managerial salaries and/or job security are thought to be related to variables such as the firm's market share, sales, or assets, rather than to profits.[3]

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[1] Oliver E. Williamson, The Economics of Discretionary Behavior: Managerial Objectives in a Theory of the Firm (Englewood Cliffs: Prentice Hall, 1964).

[2] A.A. Berle, Jr., and Gardiner C. Means, The Modern Corporation and Private Property (New York: The Macmillan Company, 1933).

[3] Ira Horowitz, Decision Making and the Theory of the Firm (New York: Holt, Rinehart, and Winston, Inc., 1970), p. 292.

Corporate sales -- not corporate profits -- are the variable to which executive salaries appear to be tied.[1] Maurer found that a substantial amount of inferior performance could be produced by management without incurring a penalty for the performance.[2] Palmer found that among firms with a high degree of monopoly power, management-controlled firms report significantly lower profit rates than owner-controlled firms.[3]

Since the government attaches considerable importance to expertise, people, and plant, its contractors are motivated to maximize these attributes. Hunt, Perry, and Rubin found evidence of the hoarding of engineers and plant.[4] Current employment of staff is associated with long-term expectations of future business, and unused plant capacity was particularly

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[1]David R. Roberts, "A General Theory of Executive Compensation Based on Statistically Tested Propositions," Quarterly Journal of Economics, LXX:2 (May 1956), pp. 270-294. J.W. McGuire, J.S.Y. Chin, A.E. Elberg, "Executive Incomes, Sales, and Profits," American Economic Review, LII:4 (September, 1962), pp. 753-765.

[2]Herrymon Maurer, Great Enterprise (New York: The Macmillan Company, 1955).

[3]John Palmer, "The Profit-Performance Effects of the Separation of Ownership from Control in Large U.S. Industrial Corporations," Bell Journal of Economics and Management Science, Vol. 4, No. 1 (Spring, 1973), pp. 293-303.

[4]Raymond G. Hunt, Ira S. Rubin, and Franklyn A. Perry, Jr., "Federal Procurement: A Study of Some Pertinent Properties, Policies, and Practices of A Group Of Business Organizations," National Contract Management Journal, Vol. 4, No. 2 (Fall, 1970), pp. 245-299.

high among firms with a high government-low commercial mix. Future survival depends on winning contracts, which depends on having ample capacity.

Although companies may not be profit maximizers, they are not indifferent to profit opportunities. Profit serves as a means to an end -- it provides the slack and discretionary funds which permit the corporation to pursue its long-range planning and growth strategies. Government policy reflects a view of profit as a corporate goal, while industry views profit as a means to a goal -- the goal of increasing sales and building a reputation. Profit is an uncertainty reducer which yields the corporations a sense of independence.

Peck and Scherer in their examination of the incentives to contractors to maximize capabilities and expertise concluded much the same thing.[1] The fact that in most cases contractors have not performed well under incentive contracts also substantiates this view. Incentives have little value to contractors as performance motivators. Respondents in the Hunt, Rubin, and Perry Study criticized the methods used to evaluate their performance and believed them unlikely to encourage exceptional performance. In practically no cases did incentives materially affect the

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[1]Merton J. Peck and Frederick M. Scherer, The Weapons Acquisition Process (Boston: Harvard University Press, 1962), pp. 457-459.

research results. In fact, line operating personnel frequently were unaware of the incentive provisions. Contractor personnel felt that the contract outcome was largely determined by the ability to maintain a substantial informal interaction with the customer. In contrast, government personnel place substantial emphasis on the appropriate form of the contract and the potential for profit to the contractor. A basic difference of opinion exists here. To the degree that contractors are not strongly profit oriented, government profit polocies and approaches to the motivation of contractors by varying profits are ineffective.

Hunt, Rubin, and Perry describe a special type of firm -- one devoted more to maximizing future capacity than to reducing present cost. Entrepreneurial activity consists of getting the next government program -- not in reducing costs or other types of actions usually associated with entrepreneurs. The typical contractor resembles a bureaucracy. He employs a large staff to handle customer relations and negotiates for budgets and levels of inputs in exchange for a program or level of effort. Measurements of the efficiency of production in terms of an output measure are unavailable.[1] Perhaps the most important aspect of all is the significance of survival as a first objective of the firm. The goal of

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[1]Niskanen's model of a bureaucracy could equally well be applied to many defense contractors. William A. Niskanen, Jr., Bureaucracy and Representative Government (Chicago: Aldine Publishing Company, 1971).

survival best explains the failure of Contract Definition to achieve the verification of design and engineering sought under DoD Directive 3200.9:

> The main motivation, overwhelming everything else, is survival. And in an environment as turbulent as defense-space contracting was during the 1960's the kinds of behavior required to maximize one's chances of surviving are quite different from and may in some respects conflict with close cost control on individual contracts. The sin qua non of survival for major system suppliers is winning new development program awards. It is to this, rather than cost control, that the bulk of top management energies was directed. As the number of new programs dwindled and as the size of individual programs rose, defense suppliers vied more and more strenuously for the few new programs available. The pressure to go along with unrealistic technical specifications requests of government planners and indeed to go beyond them became irresistible. This built-in unrealism in turn lead to the numerous performance failures and cost overruns which have now become all to familiar. The best talent in contractor technical organizations was put to work almost continuously participating in source selection competitions of a highly detailed and protracted character, but stopping short of the actual hardware development and testing through which real technical uncertainties must be resolved.[1]

4. Contractor Cost Control

The present emphasis on cost as a significant program criterion suggests that contracting methods in the past have failed to orient contractor management toward effective cost control. Cost type contracts and the lack of effective price competition have contributed to this.

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[1] Statement of Frederic M. Sherer, Weapon System Acquisition Process, Hearings of the Senate Committee on Armed Services, 92nd Congress., 1st Sess., December, 1971, p. 142

a. Cost Type Contracts

The first deficiency of a cost type contract is that it does not encourage economy nor discourage accumulation of excess capacity. A more insidious deficiency is its tendency to encourage a relaxed attitude: an attitude based on a view that "it will cost whatever it must cost" -- as if after-the-fact we will know what we lacked foresight to estimate before-the-fact. This elevates actual cost to the status of should cost when it is only a coincidence if they are the same. This deficiency was noted long ago in a study of World War II contracting policies:

> A representative of the aircraft industry summed up his company's views as follows: 'The general belief of our corporation has been that it is an insidious thing to get into the habit of operating under CPFF contracts. You can't help letting it be known that you have a CPFF contract, and the general tendency of management and I think of everybody else is to relax a little.'
>
> Evidence of efficient operations under well administered CPFF contracts were cited. The incentive in such cases, however, was not provided in the contract but instead reflected management's fear that bad habits acquired in wartime would be a serious liability in peacetime civilian production.[1]

A closely related point is Williamson's argument that both the government and its contractors have

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[1]John Perry Miller, Pricing of Military Procurements (New Haven: Yale University Press, 1949), p. 275. (Underscoring added.)

seen benefits in large, cost type contract undertakings reflecting uncertainty and defying cost-performance evaluation.[1]

b. Price Competition

The striving for competition is, in large part, attributable to a senxe of futility that many people in the government share concerning the ability to obtain economy by other means. There is a sense that efforts to control costs by audit, negotiation, or contract administration, while essential when competition cannot be obtained, are not adequate substitutes for price competition.

The "should cost" efforts are a case in point. To the extent that these efforts have been successful in obtaining lower prices on current purchases of an item, they reflect also the fact that past inefficiencies have resulted in higher costs than necessary in previous purchases of that item. Another case in point is the commentary on past results reflected in the passage of Public Law 87-653, popularly called the "Truth in Negotiations Act." There is more than casual evidence of the folk wisdom

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[1] Oliver E. Williamson, Defense Contracts: An Analysis Of Adaptive Response, RM-4363-PR (Santa Monica: The RAND Corporation, June, 1965), pp. 8-9. Essentially the same paper by Mr. Williamson is found in "The Economics of Defense Contracting: Incentives and Performances." in Roland N. McKean (Ed.), Issues in Defense Economics, (New York: NBER, 1967), pp. 217-256.

reflected in an old saying among government contracting personnel: "If you have competition, you don't need negotiators; if you don't have competition, negotiators won't do you much good." A study of competitive subcontracting by The RAND Corporation led to essentially the same conclusion that "price analysis' is apt to be a poor substitute for price rivalry."[1]

Price competition is expected to result in lower prices (or reduced costs) compared with sole source purchases. The important question is: How much lower? The answer appears to be somewhere between 15 and 50 percent lower.

* Secretary McNamara testified to Congress that an average savings of 25 cents was realized for each dollar shifted from non-competitive to competitive-type contracts. He presented eleven recent examples of savings achieved; these examples showed an average savings of 33 percent.[2]

* Later in the same hearings, Mr. William Newman, Director of Defense Accounting and Audit Division of the General Accounting Office, stated: "The figure of 25 percent saving, Mr. Chairman, I would say is conservative, based on our audit work."[3]

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[1]Robert E. Johnson and George R. Hall, Public Policy Toward Subcontracting, RM-4570-PR, (Santa Monica: The RAND Corporation, May, 1965), p. 30.

[2]U.S. Congress, Joint Economic Committee, Subcommittee on Federal Procurement and Regulation, Hearings, Economic Impact on Federal Procurement (1965), p. 13.

[3]Ibid., p. 139.

* An earlier study by LMI developed average savings of 22.5 percent experienced in competitive subcontracting by a major prime contractor.[1]

* An intensive program of competitive subcontracting on the C-141 program by Lockheed resulted in average savings of 36 percent -- the savings being measured as the difference between the sum of the low bids received from technically acceptable firms and the sum of the mean bids. The mean bids are assumed to be a reasonable approximation of the price that might have been paid if several sources had not been solicited.[2]

* An examination of some 2000 contracts let by formal advertising showed that the mean of all bids received exceeded the lowest acceptable bid by more than 30 percent in 49 percent of the cases.[3]

* A recent study of selected electronic equipments shifted from sole-source to competition concluded that "reasonable confidence could be attached to using at least a 40 percent reduction for planning purposes."[4]

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[1]Logistics Management Institute, <u>Analysis of Extent of Competitive Procurement by DoD Prime Contractors</u> (1964), pp. 31-33.

[2]Robert E. Johnson and George R. Hall, <u>Public Policy Toward Subcontracting</u>, RM-4570-PR (Santa Monica: The RAND Corporation, May, 1965), pp. 24-30.

[3]George R. Hall and Robert E. Johnson, <u>Aircraft Co-Production and Procurement Strategy</u>, R-450-PR (Santa Monica: The RAND Corporation, May, 1967), p. 163.

[4]U.S. Army Electronics Command, <u>The Cost Effects of Sole Source vs. Competitive Procurement</u> (Fort Monmouth, New Jersey, February 1972), p. 2.

* Steckler references additional examples of savings as high as 70 percent, condluding that "absence of adequate competition has increased the cost of aerospace products by about 25 percent.[1]

The cases noted all relate to equipments; none relate to systems in the sense of aircraft. To supplement these studies LMI analyzed the production costs for aircraft produced under competitive conditions -- conditions obtained where there was a close substitute in the inventory of operational aircraft -- contrasted with the production costs for aircraft where there was no close substitute. The basis of the analysis was a comparison between actual and expected costs. The analysis, which is described in detail in Appendix III, indicated that savings of as much as 15 percent resulted from competition between possible substitutes. This analysis adds yet another dimension to the subject: competition need not be over designs for identical applications. The benefit of competition are obtained if the products are substitutes for each other in application. This provides additional support for the DoD program of competitive prototyping of selected systems that has been endorsed by the House Committee on Appropriations:

> The Committee feels that to obtain the maximum advantage from the prototyping concept, competition between at least tow companies on each system should be established. The incentive which would be given the contractors involved would be substantial. The

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[1]Herman O. Steckler, <u>The Structure and Performance of the Aerospace Industry</u> (Berkeley: University of California, 1965), p. 193

one which performed best could anticipate a profitable procurement contract. The loser could anticipate no procurement contract.[1]

c. The Cost of Competition

Competition in an environment of a high degree of technical and price uncertainty has proven to be bad procurement strategy. To reduce the technical uncertainty to acceptable limits, while retaining a competitive environment, DoD must sponsor competitive development between two or more sources. Whether the incremental cost of maintaining such competition exceeds the benefits is relevant and important. The incremental costs depend on the complexity of the systems, the program phase where uncertainty will be reduced to manageable proportions, and the quantity expected to be produced. There is evidence, however, that the incremental cost may be less than supposed.

George S. Schairer developed some hypothetical cost data showing the typical flow of money into an aircraft development and production program.[2] The elements of cost for

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[1]U.S. Congress., House, Committee on Appropriations, "Department of Defense Appropriation Bill, 1972," H.R. Rept. 92-666, 92d Cong., 1st Sess., (1071), p. 13.

[2]The Role of Competition in Aeronautics, The Wilbur and Orville Wright Memorial Lecture of the Royal Aeronautical Society (London: Royal Aeronautical Society, December 5, 1968), p. 31.

a program including 500 production units were described as follows:

	Units of Cost
Design studies	4
Two prototypes plus 100 hours flight test	21
Production engineering and development test	12
Production tooling	13
Production costs -- 500 units	375
Changes during production	35
Total Program Cost	460

The incremental cost of maintaining competition between two sources through prototyping and flight test (25 cost units additional) add only 5.5 percent to the program costs in this example. Maintaining competition through production engineering and development test (12 cost units in addition to the 25) would add only 8 percent to the program. Maintaining competition through production, by dividing the total quantity between the two sources, adds substantially to the total program costs as a result of the effect of progress (or learning) curves.

It is possible that Mr. Schairer's hypothetical data give results more sanguine than would be developed for a specific new military program. Nevertheless, they suggest the possibility that competition could often be obtained at a cost less than the expected savings resulting from maintaining a competitive environment. At the very least, they

suggest that providing competition for new systems by supporting efforts to upgrade an existing system is a sound acquisition strategy. "The incremental cost to have competition by the use of model change is probably always negative and very favorable. ...I can assure you that it was the competitive threat that the Air Force would buy a new airplane from somebody else that caused Boeing to devise the (B-52) G and H designs."[1]

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[1]Ibid., pp. 31-32

APPENDIX D

February 13, 1979

MEMORANDUM FOR DR. MARTIN

SUBJECT: Establishing Second Source for Production of Defense Equipment

By memorandum addressed to the Assistant Secretaries of the Services and the Director, DLA, dated 18 January 1979, Mr. Dale W. Church expressed his desire to identify one or more alternative acquisition strategies which would more often lead to establishment of a second source at an early period in a production cycle. He solicited recommended alternatives to be discussed at a meeting on 14 February 1979, the purpose of which was to arrive at a point where some uniform guidance may be drafted (Atch1).

By memorandum dated 29 January 1979, you designated the undersigned to attend as the AF representative and expressed your intention to be kept fully informed as to the proposed recommendations (Atch 2).

I have met with representatives of the Air Staff for the purpose of discussing the nature of the problem and to consider our inputs, including responses to a message sent by the Air Staff to AFSC and AFLC (Atch 3). The result is a Talking Paper (Atch4) which I propose to give to Mr. Church at tomorrow's meeting.

HARVEY J. GORDON
Deputy for Procurement

4 Atchs
1. Dale Church Memo dtd. 18 Jan 79
2. Memo 29 Jan 79
3. Message to AFSC/AFLC
4. Talking Paper

CY: AF/RDC

TALKING PAPER

ESTABLISHING SECOND SOURCE FOR PRODUCTION OF DEFENSE EQUIPMENT

There is no one recommended alternative to best establish a second source for production of defense equipment. There are a variety of acquisition methodologies which can be used, but each approach has attendant consequences which may be either assets or liabilities. Therefore, it is our view that the subject is best addressed in the following logical sequence: policy goal(s); intrinsic nature of the defense equipment to be acquired; and, available acquisition strategies/ methodologies.

There are many reasons for establishing a second source, one or more of which may apply to any given acquisition. Some of these reasons are compatible with one another and some are not. Those we have identified are (1) broadening the production base, (2) evening out the fluctuation in defense industry which leads to feast or famine situations for individual firms, (3) achieving savings through increased competition, (5) facilitating NATO participation as co-producers or through offsetting coproduction as subcontractors, (6) facilitizing the attainment of socio-economic goals by increased award to minority and small business contractors and/or subcontractors, and (7) preserving competition for the sake of competition per se.

To insure selection of the acquisition alternative which would best accomplish establishment of a second source early in a production cycle first requires prioritization of the above goals. There is no one methodology which can accomodate all these goals in any given acquisition. OSD guidance must recognize this fact and should not be couched in terms of recommended contracting alternatives. There are contracting alternatives but their order of preference is dependent upon which policy goal or combination of goals is sought in the instant acquisition.

Having resolved the policy goal(s) to be met, it is essential to then understand and evaluate the intrinsic nature of the defense equipment to be produced. The following list, perhaps not all inclusive, enumerates the kind of factors which influence acquisition planning in selecting the preferred alternative:

(1) Intrinsic nature of the item to be produced in terms of its technical complexity, the state of the art, the fabrication process involved, and the tolerance required;

(2) Existing industrial capacity;

(3) Ultimate quantity to be produced and the rate at which the Government will place orders for production;

(4) Production leadtime;

(5) Investment in capital facilities and tooling required for production;

(6) Production startup and other nonrecurring costs, including first article acceptance testing;

(7) Logistics concept to be employed;

(8) Political environment;

(9) Degree to which production will require access to proprietary technical data and/or manufacturing process; and

(10) Potential for commerciality and/or the existence of essentially equivalent hardware in the commercial sector.

With answers to the aforementioned, together with identification of the DOD goal(s), it is feasible to evaluate which of the following contracting methodologies may best accomodate establishment of a second source early in the production cycle. These options, not listed in any particular order of preference, are:

(1) Establishment of a Qualified Products List (QPL), best suited for instances where there is a continuing requirement, the costs for qualifying the product are not unreasonable, and the quantity and rate at which the equipment is acquired facilitates uninterrupted production by competing producers.

(2) Leader/Follower Concept wherein the producer provides technical assistance and data rights necessary for other concerns to coproduce. The coproducer can be a designated subcontractor, a subcontractor selected by the prime producer, or a direct supplier to the Government. This is best accomplished by competition for full scale engineering development in the form of data rights and priced options for technical assistance.

(3) Coproduction wherein the Government, in proposal evaluation and source selection for full scale engineering development, requires submission of a detailed coproduction plan to insure there is a subcontractor(s) who will produce concurrently deliverable end item equipment, priced in the production option.

(4) Use of 10 USC 2304(a) (16) to permit award to two concurrent production contracts with a price premium paid to insure award to a second source.

(5) Direct licensing (providing for the payment of a royalty or a license fee) to facilitate one or more additional sources to compete in follow-on production.

(6) Acquisition of a reprocurement data package either for the entire system, selected subsystems, and/or selected components.

(7) Two-phase acquisition in which the first phase is limited to design and development with unrestricted competition for production in accordance with the Government's detailed production specification.

(8) Breakout after initial production of subsystem(s) or major components for direct acquisition by the Government.

(9) Multi-year procurement of production after the initial production buy to insure a production base sufficiently substantial to facilitate meaningful competition by concerns other than the initial producer.

There are several acquisition policies which, to varying degrees, impede second source production. To the extent we emphasize design-to-cost and life cycle costs, these operate against competing the subsequent production and/or second sourcing. It is not feasible to impose RIW commitments on a developer in the case of production equipment manufactured by a second source. It may not be feasible to implement design-to-cost incentives on a developer for production equipment manufactured by another source. Equally troublesome is the difficulty of incentivizing life cycle cost goals when production equipment may be manufactured by two or more producers. Where the logistics concept and life cycle costs considerations are pre-eminent and strongly favor manufacture of standardized equipment by one source, the policy objective of establishing a second source in an early period of the production cycle may be inherently inconsistent.

While there are several possible alternatives, no particular one is ideally suited to best accomplish the early establishment of a second source in the absence or consideration of and regard for competing DOD policy goals and objectives. The selection of the preferred methodology is in large measure dependent upon an indepth understanding of the nature of the equipment to be produced and the nature and funding of the program. This means that the problem must be worked on a case by case basis. Evaluation must be made as early in the development/acquisition cycle as possible to insure that the various options are not inhibited by business, budgetary and/or policy decisions made in the absence of a full understanding of their consequences.

SAFALP/Harvey J. Gordon/February 13, 1979

APPENDIX E

The information presented in this Appendix is excerpted from a June, 1979 Master's Degree thesis by LCDR D.S. Parry, SC, USN, which was written at the Naval Postgraduate School. This Appendix presents several case studies which are examples of some second sourcing/production competition efforts that have been made in the past. Some of these efforts have been considered successful, while others have clearly failed to accomplish their objectives. This Appendix is provided in order to point out some of the benefits that can be achieved through second sourcing as well as some of the risks associated with its application.

IV. CASE STUDIES

The following case studies are provided as illustrations of second sourcing efforts that have been attempted to date. Included are examples that have been declared successful as well as some that have been branded failures. It is hoped that examination of such cases will point out some of the benefits that can be achieved through second sourcing as well as the costs associated with application of the method.

ARN-84 AIRBORNE TACAN NAVIGATION SET -- The original developer/ producer of the solid state ARN-84 was Hoffman Electronics, now the NAVCOM Division of Gould, Incorporated. Hoffman was the sole-source producer of the ARN-84 until 1975 when the Naval Air Systems Command (NAVAIR), believing that Hoffman's price of $26,000 per set was excessive, decided to second source the following year's acquisition. The Navy utilized a re-procurement data package, originally prepared by Hoffman, to initiate the competition. Although Hoffman drastically cut its previous price for the ARN-84 (quoting $17,000 per set), they were underbid by ASC Systems which submitted a bid for only $13,000. Hoffman informed the Navy that the $13,000 figure was less than the direct material and labor costs it had experienced over the duration of its previous production contracts. At that time, however, Hoffman had lost a great deal of its credibility -- evidence the $9,000 drop in the price quoted by Hoffman.

ASC Systems (a small business) is a wholly-owned subsidiary of LaPointe Industries and is located in Connecticut. Historically, ASC Systems had, after some initial production difficulties, performed successfully as a second source for production of the ARC-51 airborne UHF radio communications transceiver. When identified as the low bidder on the ARN-84, a Navy pre-award survey team visited the company and concluded that it appeared qualified as a producer of the TACAN. The initial contract was subsequently awarded on 12 September 1975 for a quantity of 200 sets at a total price of $3.2 million -- with first production units to be delivered in February 1977.

By June 1977, the Navy was in a position wherein it needed at least 200 more units to meet subsequent years requirements. In a four firm competition, ASC Systems again underbid all competitors at a price similar to that of its first contract. The pre-award survey team again visited ASC Systems and reported good progress on the original contract.

The first production prototype passed qualification tests in the fall of 1976. Later that year, however, the Navy received a request for a several month extension of its first production deliveries on the grounds that it had never been notified "in writing" that the first production prototype had passed qualification tests (specifically a 500 hour mean-time-between-failure test). Unfortunately, the Navy found that someone in the contracts branch had, indeed, failed to mail the required notification. The Navy was thus forced to accept an extension of the first deliveries until mid-1977.

Concurrent with this revised delivery schedule, the Navy had a third ARN-84 buy in sight. Hoffman informed the Navy that, if a third buy went to ASC Systems, Hoffman would close its TACAN production line. At this time, it was becoming evident that ASC was experiencing difficulties in the manufacture of acceptable full production models. If Hoffman dropped out of the market and ASC failed to resolve the difficulties it was experiencing, the Navy would be in real trouble. Navy representatives thus contracted with Arinc Research Corporation to act as consultant to ASC Systems. In late 1977, however, ASC Systems' production units were failing to pass required tests. The situation, at that point, was so critical that aircraft were coming off the production lines without TACANs. Ferry pilots were even carrying TACAN sets with them to allow acceptance of the new planes.

Consequently, the Navy awarded a sole-source contract to Hoffman for the third year buy at a price of $17,000. In July 1978, ASC Systems' full production units still had not passed the required 500 hour Mean-Time-Between-Failure (MTBF) tests, but, because of the urgent need for the units, the Navy agreed to accept twenty sets if they could merely pass a fifty hour burn-in test. In the following month, only two units were delivered. In September, it was decided to terminate both contracts. The terms of the settlement (called a discontinuation) were to entail three distinct phases. Phase I allowed payment of up to $4.3 million in allowable/allocable costs on the two contracts. In phase II, ASC Systems can submit a

"terminating claim" -- to be examined by the Termination Contracting Officer who has the right to determine whether or not more than the initial $4.3 million is due. In phase III, the door would be opened for the submission of claims, however, the total settlement cannot exceed $5.2 million under any circumstances.

When questioned about the problems ASC Systems encountered, Jack Lopes (president of La Pointe) stated that "There is a lot of information that is not included in the drawings." /1:53/ He also claimed that the delivery schedule was exceptionally tight and that he had had insufficient engineering talent on board to resolve the data package difficulties. An additional problem noted was that the sub-contractor, responsible for providing a required voltage regulator micro-circuit, was providing ASC with units of inadequate quality. Since ASC did not inspect these units on receipt, the quality problems were not identified until it was too late.

The bottom line in this case is that second sourcing to ASC Systems has cost the Navy approximately fifty percent more than purchase from the original source would have cost. Though, as noted, it appears obvious that Hoffman's 1975 price was indeed inflated and in need of trimming, the case illustrates how second sourcing can result in many problems -- especially where actual qualification of the second source is not achieved or where its production units cannot pass necessary acceptance tests. Also in question is the quality of the pre-award survey and the ability of small business to perform adequately in major systems acquisitions.

TSEC/KG-40 MICROMINIATURIZED KEY GENERATOR -- The KG-40 is utilized for encription and decription of data being transmitted over certain military tactical data links. In 1971, the Naval Electronics Systems Command (NAVELEX) awarded a development contract to Collins Radio Company of Newport Beach, California for the KG-40. In 1973, a sole-source letter contract was awarded to Collins for a quantity of 266 serial units at a price of $22,874 each and 94 parallel units at $33,367 each. Two years later, Collins was again awarded a sole-source contract for 288 serial units at $20,463 each and 74 parallel units at $30,581. In 1977, believing that Collins was exploiting its sole-source position, NAVELEX decided to attempt second sourcing of the KG-40. In coming to the decision to second source that year's contract, NAVELEX did a careful analysis of the risks and of the quantity projections for future buys. Additionally, NAVELEX identified several established and responsible contractors that were believed capable of performing the contract. NAVELEX also audited and verified the KG-40 technical data package -- finding it sufficiently complete and accurate.

The 1977 contract was awarded competitively to Honewell Corporation of Tampa Florida. The contract called for 245 serial units at $8,931 each and 686 parallel units at $11,882 each. Collins' offer had quoted prices of $15,384 and $20,523 for the serial and parallel units respecitvely. NAVELEX, in trying to estimate the total savings associated with the second sourcing of the KG-40, applied three years inflation to the

unit prices paid to Collins on the previous sole-source buy and then reduced these figures for the volume of the current but on a 90 percent learning curve. The savings, so calculated, are estimated at a healthy $14,800,000. Another directly measurable benefit of the competition was the fact that NAV-ELEX was able to increase the quantity of the contract by approximately two thirds -- as a result of the lower prices paid to Honeywell. Also noteworthy was the significant drop in Collins' quoted prices (ostensibly as a direct result of the competition).

Though the cost savings achieved are significant, there are other collateral benefits associated with this particular second sourcing effort. There are now two fully qualified producers of the KG-40; five other sources have been identified as technically capable of producing the KG-40 (valuable to future competitions); and, although the technical data package was not totally flawless, with the aid of models and careful contracting, the acquisition achieved success.

AIR-7F SPARROW MISSILE -- The Sparrow is a medium range air-to-air missile, with solid state electronics, which guides semi-actively to a target. Several major components of the Sparrow have been second sourced or considered for second sourcing and therefore deserve exploration:

Guidance and Control (G&C) Sections -- Development studies leading to the AIM-7F G&C were initiated with Ryatheon in 1964. The first production contract was awarded to Raytheon to furnish not only the G&C sections but also such related items as

telemetry, wings, fins, integrated logistic support (ILS), special tooling, special support equipment, design data tests, technical support services, and data. Later awards to Raytheon required such tasks as performance improvement, G&C design simplification, aircraft interface and operational testing, and evaluation (including user system testing and production units). The data package resulting from this work was considered adequate to permit second source production of the Sparrow, so, in 1973, a CPFF contract with a CPAF option was issued to General Dynamics (GD) as a result of a technical/cost competition to establish GD as a second source G&C producer. The contract provided for performance in two stages: (1) data generation in connection with production preparations ($1,158,233), and (2) manufacture and delivery of 15 first articles and a total of 70 learning quantity production units ($21,189,961). First article delivery took place in May/June 1976, and, for funding reasons, the learning quantity was later transferred to a separate contract with government liability limited to $8.1 million. Since issuance, however, the cost of those 70 units has risen to $13.5 million. The following will demonstrate the full production contract profile of the two sources from 1976 to the present:

	RAYTHEON			GENERAL DYNAMICS	
CONT TYPE	# UNITS	($K) APPROX UNIT PRICE	CONT TYPE	# UNITS	($K) APPROX UNIT PRICE
FFP	880	89	FPI	210	164
FFP	1110	74	FPI	210	106
FFP	1398	70	FFP	750	83

When the Navy announced that it intended to second source the Sparrow, Raytheon prepared a rather interesting analysis that concluded the need for a 34 percent reduction in program costs before second sourcing could be justified on the basis of cost savings (assuming a 70/30 split on the purchase of 4570 missiles over a five year period). Raytheon further concluded that not until production rates of 2200 missiles per year were required would second sourcing be "in the national interest." Instead, Raytheon recommended two alternatives to second sourcing that it claimed held excellent potential for savings:

(1) Allocate funds to provide for multiple sourcing of additional components beyond those now multiple sourced and by that means achieve the benefits of increased competition at the component level.

(2) Increase the effort on value engineering. Those components which can be made more economically through value engineering changes will benefit the Navy with a single source as well as with a second source if one is established. /2:3/

Among the other arguments against second sourcing the Sparrow that Raytheon offered were:

(1) Additional tooling, qualifying, and management costs associated with second sourcing.

(2) Progress along any assumed learning curve is more rapid in the case of a single source than when procurement is split.

(3) Additional costs are realized because of production verification testing with two manufacturers. /2:4/

Raytheon, then, did not argue that the concept of second sourcing, as such, was invalid -- only that is should not be applied to the Sparrow. Based on production experience with two sources, Raytheon went on to calculate what it claims is a $108.2 million cost increase between sole-source and dual source production of the Sparrow between 1974 and 1978 (including $48.6 million in learning missile qualification, tooling, and test equipment).

NAVAIR's analysis of the AIM-7F second sourcing effort was somewhat different. By extrapolating along the learning curve for Raytheon's sole-source production of the Sparrow, NAVAIR estimated that through FY 1977 Raytheon's price under competition was $42.2 million less than would have been expected. NAVAIR thus estimated that it would break even on the Sparrow in FY 1979. Regardless of the economic analysis utilized, NAVAIR achieved several non-financial benefits from this second sourcing (including design improvement and mobilization base expansion).

Mark 58 Model 3-Rocket Motors -- Hercules, Incorporated developed the Sparrow's rocket motors under a fixed price subcontract to Raytheon. Subsequently, Hercules became a sole-source producer for the motors. Prior to fiscal year 1976, the net cost per unit for the MK 58 was approximately $8,400

and there appeared little hope that the price would ever go below $6,500 per copy. At that time, the government representatives estimated that second sourcing the motors could eventually lead to a price of about $5,500. At the same time, however, Hercules was able to identify a new supplier of metal parts. That find, coupled with an increase in procurement quantities for the motors, enabled Hercules to cut its prices to about $5,400. Since it seemed unlikely that a new source could attain this lower price, Class Determination & Findings (CD&F) 77-73 disapproved the request to second source the motors. Subsequent problems with the metal parts producer and with Hercules, however, have resulted in NAVAIR reconsideration of the need to second source. Depending of a reassessment of future needs, a second source may be pursued.

<u>Safety and Arming (S&A) Device-Mark 33</u> -- The Mk 33 was originally developed by Barry L. Miller, Incorporated of Gardena, California. Consolidation of Miller's activities as a consequence of the purchase of the Gardena plant and the subsequent decision to cease production of the S&A device resulted in the loss of the only qualified production source. Competitive RFP's were utilized to award the 1973 buy of 150 units and first articles to Piqua Engineering of Piqua, Ohio (FFP contract for $66,240). The 1974/1975 contract requirements for 710 units were split under a mobilization base exception. Four hundred fifty units went to Piqua (FFP contract for $159,660) and 260 units went to Raymond Engineering at a price of $230,980. In FY 1976, the split awarded 800

units to Piqua and 360 units to Raymond; and, in FY 1977 the split was 1320 units to Piqua and 362 to Raymond. Although the FY 1978 award has not been definitized, it is known that Raymond will receive the largest portion of the award. Unfortunately, deliveries over the past few years have been running about six months behind schedule. NAVAIR is therefore planning to add a third source in the future.

Experience with the Sparrow has shown that, with some complex systems, the use of a TDP for development of a second source is feasible; however, the costs associated with such action may be significant.

TALOS MISSILE -- In 1961, Bendix Corporation was awarded a sole-source contract for the production of the TALOS surface-to-air missile system. Bendix subsequently produced this missile for the Navy as a sole-source until 1966. In that year, the Navy decided to attempt second sourcing of the TALOS. The "know how" and experience gained by Bendix over the course of five years of production as a sole-source supplier of the system stood them in good stead during the second sourcing effort. Bendix won the contract for production of the TALOS through the end of the program in 1968. Of real interest is the analysis of the costs associated with the procurement of the TALOS from 1961 to 1968. The original production contract was awarded at a per unit cost of $219,000. The learning curve demonstrated over the next five years was a shallow one (indicating little improvement), with the unit price on the 1965 purchase

being $160,000. Extrapolating the learning curve, the expected sole-source price of the 1966 contract totalled $155,000 per unit. The award price for the contract, however, was only $92,000 per copy -- 41 percent less than projected. The savings on the 470 missiles purchased under this contract is thus estimated at $32 million. It seems that even though the original producer won the contract, the mere existence of competition for the reprocurement extracted significant concessions in the price charged.

SIDEWINDER MISSILE -- The Sidewinder is the name given to a family of heat seeking air-to-air missiles (AIM-9 series). The first Sidewinder was developed at the Naval Ordnance Test Station (NOTS) in the early 1950's and was originally produced in 1954. The fourth version of the missile was developed in 1960 and PHILCO was awarded a contract to help with pilot production and data package development for the G&C System. In 1964, the Navy advertised in the Commerce Business Daily (CBD) for production of the AIM-9D. Raytheon was the low bidder (40 percent below PHILCO) at $5,000 per missile. Raytheon was thus awarded a FFP contract for production of the Sidewinder in January 1965. As a term of the contract, Raytheon had to prove its ability to produce by manufacturing a quantity of ten G&C units (4 for standard Navy testing by Raytheon itself 6 for extensive ground, sled, launch, and in-place flight tests by NOTS). Raytheon failed in its first attempt to qualify as a Sidewinder producer but was finally successful three months later. Although PHILCO had been able to build its missiles

from Navy drawings, Raytheon attributed its difficulties to an inadequate data package. The resulting systems had experienced low yields, and, as a result, many components had required extensive rework in order to meet specifications. It took substantial effort on the part of Raytheon, NOTS, and NAVAIR before the problems were overcome.

Raytheon claimed that following the requirements of the data package did not guarantee production of qualified units -- they thus sued the Navy for $14.0 million. The case never got to court, but, the $6.6 million settlement agreed to by the Navy tends to support the validity of Raytheon's claim. Subsequently, Raytheon produced several hundred AIM-9D's and approximately 6,500 of the successor AIM-9Gs. The Navy instituted competitive second sourcing attempts for the AIM-9G production lots, but, Raytheon always won the competition.

The next version of the system was the solid state AIM-9H. With this system, the Navy received developmental assistance from both Raytheon and General Dynamics. In the following production phase, Raytheon was awarded a contract for 1,100 missiles and PHILCO-FORD won an additional 700 units in competition with General Dynamics. The Navy, then, offered a contract for an additional 470 missiles which was eventually awarded to PHILCO-FORD. Of special note, here, is the tactic utilized by the Navy to preclude recurrence of the data package problems encountered with the AIM-9D. Provision was made for the payment to Raytheon (the development contractor) for the identification and correction of inconsistencies in the

data package and specifications. The consequent successful performance was considered to have more than justified the additional expense incurred. This success also tends to reinforce the contention that the data package alone is frequently inadequate for the transfer of technology whereas interface between the development/original production contractor and the second source can assure effective transfer. The fact that engineering liaison is one of the first prerequisites cited as necessary for successful commercial licensing makes this observation all the more convincing.

GAU-8A 30MM AMMUNITION -- In 1973, the Air Force A-10 System Project Office (SPO), at the completion of a competitive prototype phase, awarded a contract to General Electric Company (GE) for the GAU-8A gun system. The contract called for full-scale development and follow-on production of both the gun and its associated ammunition. GE's cubcontractor for the ammunition development and production was Aerojet Ordinance and Manufacturing Company. DSARC II, in 1974, directed GE to develop a second source for ammunition to satisfy mobilization base and production quantity requirements and to provide for production competition. In fact, the concern was voiced that even if it were impractical to second source the gun itself, a real cost savings potential existed in the case of the ammunition. As in the case of razors and razor blades, ammunition, though not the major implement/tool, accounts for a great deal of the overall life cycle cost of the system.

Three major companies competed for the second source contract. Honeywell was finally selected. GE was still the gun system integrator, but there were to be two ammunition suppliers. Another interesting aspect of this buy was the stipulation that no technological transfer/transfusion between the two ammunition manufacturers could occur. The only requirement was that the ammunition be "form-fit-function" compatible. This stipulation was enacted because of fears that if Honeywell were to merely produce the ammunition to Aerojet's drawings, both companies would be likely to use the same sources for their materials -- a move that would do nothing to expand the mobilization base even though it would introduce some measure of price competition.

At the end of full-scale development, the procurement plan and the DCP specified that initial production buys of the ammunition would be achieved through the integrating contractor. It was further averred that it was too early to bring the second source into production since Honeywell has not yet been fully qualified. The SPO, however, took a calculated risk and directed production sub-contracts to both sources in the hope that Honeywell would soon qualify. A split of 60 percent to Aerojet and 40 percent to Honeywell was awarded on that initial production buy.

In 1976, the procurement plan still called for purchase of the ammunition through the prime integrator, but, the SPO decided to break away from the integrator and buy directly from the two sub-contractors pursuant to the mobilization base

exception. The RFP specified a minimum sustaining rate (20 percent of the total buy) -- guaranteeing that no less than that amount would be awarded to either competitor. Above that minimum level, the offerors were to bid at 16 percent intervals (six separate proposal points) for the entire buy. The major evaluation criteria were cost and mobilization support and planning. Cost and pricing data were required and full field analysis by the Defense Contract Administration Service (DCAS) and the Defense Contract Audit Agency (DCAA) were accomplished, with the results used in the discussions with the two sources. Eventually a best and final offer was solicited and both offerors were awarded quantities in excess of the minimum sustaining rate, indicating a fair degree of competition had been achieved.

Another interesting aspect of this acquisition was the requirement that the offerors build a capacity for a defined peak production (FY80 requirement). In other words, both had to have peak year tooling -- meaning excess individual capacity. The two contractors refused to comply at first, however, the SPO overcame the problem by the use of a special termination clause entitled "Cost Recovery for Contractor Facilities Investment." This clause effectively says that if the acquisition is terminated, the government will assume the cost of the unamortized book value of the extra capital equipment. At the same time, there was a great deal of controversy surrounding the use of this clause; however, it was determined that the clause would not constitute a violation of the Anti-

Deficiency Act since termination of an out-year contract would also mean cancellation of the instant contract thereby freeing funds for the termination. The SPO claims that the only real risk to the government occurs in the first two years. After that, given that used machine tools are constantly appreciating, risk is believed to drop to zero.

Among the lessons learned by the Air Force during the FY77 buy were that there were too many proposal points; there should have been an interpolation method between points; every potential award point should be incentivized (thereby preventing any "loading" of the low award points); and, there was no need to include any subjective evaluation criteria (price alone was a sufficient criterion for this acquisition).

For the FY1978 award, a Dual Competitive Award Methology (DCAM), which incorporated the above lessons learned, was utilized. /37/ The results of that buy were truly noteworthy. Procurement cycle times were reduced dramatically, and, the savings estimated for that single buy are on the order of $17.0 million -- which allowed a 15 percent increase in the acquisition quantity to be awarded at a price lower than had been projected for the original quantity.

This case illustrates how Form-Fit-Function can be used to effect successful second sourcing of relatively simple systems. Here, although second sourcing was initiated for mobilization base reasons, use of contractual language that indemnified the second source from loss as a result of tooling-up for production, resulted in the qualification of two sources who then

competed vigorously for the larger portions of the awards. Price concessions thus were realized as a collateral benefit for follow-on purchases.

CRUISE MISSILE -- The Cruise Missile engine is an example wherein a directed technology licensing (DL) arrangement is being utilized to provide a second production source. The Cruise engine was originally developed by Williams Research Engineering and Manufacturing. Given the importance of the Cruise Missile to the national defense effort, it was determined that alternate sources must be developed to ensure the integrity of the system against destruction of the sole-source of manufacture. The Joint Cruise Missile Project Office (JCMPO) thus tried to enduce Williams to agree to a licensing agreement whereby a second source for the manufacture of the engine could become qualified. When all attempts to secure such an agreement failed, it was decided that the requirement for an alternative engine be advertized in the Commerce Business Daily and draft RFP's be submitted to industry.

Faced with the development of an alternative engine, Williams finally agreed to the licensing of its engine. The project office told Williams to consider a total of six manufacturers as potential second sources. Since the government believed that more than enough adequate production facilities already existed in the market, it was stipulated that no new facilities were to be constructed in connection with the contract. The first source recommended by Williams was rejected by the government evaluation team; however, Teledyne which

was determined to have sufficient capacity, technical competence (since they were presently producing Harpoon Missile engines), and an excellent engineering staff, was approved as a second source by the government.

The JCMPO is presently negotiating a definitive licensing agreement. Among the important factors being addressed are sharing arrangements, royalties, and, where applicable, maintenance. The fact that both sources will be capable of competing for both manufacture and maintenance of the Cruise missile engine has stimulated optimism about potential for significant cost savings downstream.

The Air Launched Cruise Missile (ALCM) is expected to be produced under a Leader-Follower concept (under a mobilization base exception). Two alternative methods of selecting the follower are being considered: (1) competitive selection of the follower, or (2) selection, by the government, of the unsuccessful development offeror as the follower. One important element in the source selection process will be the technology transfer plan of the offerors. This plan is to have three elements: a master schedule for follower development (complete with meaningful contract events); a statement of work outlining what the leader must do to make the follower capable of producing forty percent of the contract requirement; and, a proposed work task statement for the follower. The initial contract period for the leader-follower arrangement is fiscal year 80/81. The first year's technology transfer effort is to be directed at completely indoctrinating the follower (acting as a sub-

contractor) in the leader's manufacturing approach and at preparing the follower for pilot production.

During the next year, the follower still operates as a subcontractor and the technology transfer effort is designed to result in limited production of the complete system. A capability must be developed such that the follower is capable of producing between 40 and 60 percent of the FY 1982 purchase.

In FY 1982, it is projected that the follower will be tasked with producing 40 percent of the leader company's production requirement -- still in a subcontractor capacity. In case the follower encounters difficulties, the leader can reduce this quantity in consonance with the level of production capability demonstrated by the follower.

In all subsequent buys, awards will be made under full competition with government contracts being awarded to both sources. Government tooling will be shared by both contractors with a minimum of 40 percent going to either contractor. Buy-out (winner take all award) may be executed at any time by the government. Although this acquisition is in its early stages, the procedures being utilized appear instructive. Another good example of the use of the leader-follower technique is found in shipbuilding contracts. Much has been devoted to this program in the literature /4/ so it will not be covered in this study.

AIRBORNE SELF-PROTECTION JAMMER (ASPJ) -- The U.S. Naval Research Laboratories originally designed and developed the ASPJ with the stated objective of providing all Navy tactical aircraft with an acceptable probability of success and survivability during the 1980's and beyond. It is currently scheduled for the F-18/A-18, F-14A, EA-6B, A-6E, and AV-8B aircraft as a minimum. Eventually, as many as four thousand aircraft could carry these units, making this program worth some $2.0 billion.

One of the objectives of the program is to have a high initial produciton rate that will be maintained for a considerable period of time. No single company could handle the projected production schedule; and, at the same time, the potential dangers of sole-source acquisition make the idea of production competition especially attractive on a project of this magnitude. NAVAIR, thus, introduced a relatively new concept for this acquisition -- contractor teaming. Presently, two teams have been selected to produce engineering development models: ITT/Westinghouse and Sanders/Northrup. Following a critical design review in January 1980, a single team (both members of which will be fully qualified producers of the entire ASPJ system) will be selected and production quantities will be awarded to the menbers of that winning team. Quantities awarded to the individual team members will be determined on the basis of an award competition between the two former team mates. The split itself will be determined on the basis of cost to the government -- the combination that is cheapest

overall. Initial production deliveries are scheduled to begin in mid-1980.

The teaming concept is an intellectually intriguing one. The question remains whether or not two historical adversaries can or will engage in the full interchange of information and technology necessary to enable both to establish fully competent independent production lines capable of producing the entire system. Since the resultant product will have been co-developed, the award criteria for production buys will hinge on price, quality, and delivery performance. To date, problems encountered encompass such factors as management coordination, proprietary data and process considerations, division of labor, and other such parochial concerns. It is yet to be determined whether or not the incentives for cooperation ($2 billion in combined sales) will be able to overshadow the selfish concerns of the individual members.

The enormity of this project will most definitely have an adverse effect on any losing team -- in fact it has been postulated that the Electronics Warfare market will necessarily shrink because many of the losing contractors will be unable to recover from the loss of this contract. Perhaps the advantages of cooperation, in this case, are too overpowering to be overlooked. One government representative expressed sincere concern, however, that the lead member of any team will have significant incentive to ensure that the other member is never quite fully equal to the leader -- thereby securing for that leader a competitive advantage on furture procurements.

Regardless of the outcome, teaming is a stimulating concept and ASPJ should be studied carefully in order to determine the viability of the method for future projects.

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